APPENDIX A

Nos. 72-1892-93

UNITED STATES COURT OF APPEALS

For the Sixth Circuit

THE DUNLOP COMPANY, LIMITED,
Plaintiff-Appellant
and Cross-Appellee,

v.

KELSEY-HAYES COMPANY,
Defendant-Appellee
and Cross-Appellant.

APPEAL from the United States District Court for the Eastern District of Michigan, Southern Division.

Decided and Filed August 24, 1973.

Before: PHILLIPS, Chief Judge, LIVELY, Circuit Judge; and O'SULLIVAN, Senior Circuit Judge.

LIVELY, Circuit Judge. The subject matter of the two patents involved in this appeal is disc brakes. As originally filed, the complaint by Dunlop alleged that Kelsey-Hayes was infringing four Dunlop patents. Patent number 2,790,516 (hereafter '516) was issued to Dunlop by the United States Patent Office on April 30, 1957, application having been filed on January 22, 1951. In the application for this patent the invention was described as relating to disc brakes and disc brake assemblies for motor vehicles. It was stated that the object of the invention was to provide a disc-type brake for motor vehicles and to provide a wheel and disc brake assembly for motor vehicles. Patent number 2,921,650 (hereafter '650) was issued to Dunlop by the United States Patent Office on January 19, 1960, application having been made on September 14, 1954. This application recited that

the invention related to disc brakes, and more particularly to disc brakes for heavy vehicles, rolling stock, industrial machinery and the like.

In its answer Kelsey-Hayes asserted that the patents were invalid and denied infringement. It also pled a number of affirmative defenses under 35 U.S.C. §§ 102 and 103 and further charged Dunlop with inequitable conduct and violation of the antitrust laws of the United States. In addition to asking that the patents in suit be declared invalid and not infringed, Kelsey-Hayes sought treble damages against Dunlop and its attorneys fees in the action.

Issues of validity and infringement with respect to all four patents were decided by the District Court, but the rulings with respect to the '516 and '650 patents only have been appealed. The District Court held that '516 is invalid and has not been infringed, and that '650 is valid, but that it has not been infringed by Kelsey-Hayes. Although Dunlop has been a pioneer in the development of automotive disc brakes, neither of the patents in controversy relates to the primary invention of the disc brake. What is involved are certain features of so-called "fixed caliper disc brakes." Prior to World War II drum or shoe brakes were used almost universally on automobiles both in Europe and the United States. During the war disc brakes were developed for military aircraft and both Dunlop and Goodyear Aircraft Corporation, a subsidiary of Goodyear Tire and Rubber Company, were extensively involved in the production of disc brakes for this purpose. The wartime success with disc brakes on aircraft produced an interest in the adaptation of such brakes to automobiles. Dunlop was the leader in England in the development and production of disc brakes which were used on English and European sports cars. The Jaguar was equipped with disc brakes and Dunlop granted licenses to several European automobile manufacturers who equipped their products with Dunlop disc brakes. An exclusive license for automotive use in the United States was granted by Dunlop to Bendix Corporation and this

applied to then existing as well as subsequently issued patents.

There was serious resistance to the use of disc brakes in the American automobile industry, based primarily on the fact that disc brakes then in production were designed for the generally lighter European cars and it was felt that they would not perform effectively on the heavier and more powerful cars produced in this country. In January 1961 at a convention of engineers in Detroit an official of Dunlop made a speech in which he discussed automotive disc brakes. Kelsey-Hayes was a leading manufacturer of automotive drum brakes in the United States, and following the Detroit speech, its officers made contact with officers of Dunlop concerning the possibility of further development of the disc brake industry in this country. There were a number of visits back and forth between the personnel of Kelsey-Hayes and Dunlop, and Dunlop released a large quantity of technical information about automotive disc brakes to Kelsey-Hayes. Because Bendix had an exclusive license in the United States from Dunlop, the only way that Kelsey-Hayes could enter the business using Dunlop patents was to obtain a sublicense. On or about July 1, 1963 Bendix did sublicense Kelsey-Hayes under the patents in litigation. Kelsey-Hayes canceled the sublicensing agreement on December 31, 1965, and Dunlop claims that it has been infringing continuously since that date.

The disc brakes and assemblies involved in the disputed patents may be described generally as consisting of a disc or rotor which is attached to the axle and turns with the wheel, and a housing which is fixed to a stationary portion of the vehicle and is of an inverted U-shaped design and positioned so that it envelopes only a portion of the disc. The U-shaped housing consists of a bridge-like part which is set across the top of the disc and perpendicular to its plane and arms extending downward from either side of the bridge, with the disc rotating freely within this structure. Each arm has one or more chambers or cylinders in

which pistons are fitted. These pistons are aligned transversely to the plane of the disc. Friction elements or asbestos brake pads, either with or without backing plates, are placed within the housing between the disc and the pistons. Hydraulic pressure is maintained at a level when the brakes are not activated which positions the friction pads within a few thousandths of an inch from the disc. When the brake pedal is depressed additional hydraulic fluid is forced into the cylinders and this moves the pistons toward the disc. The pistons on each side of the disc then push the friction pads against the disc. This pinching or squeezing of the pads against both sides of the disc simultaneously forces the disc to stop turning, which results in a stopping of the vehicle since the disc is attached to the same mechanism as the wheel. When the friction members engage the disc, hydraulic pressure causes them to be slightly compressed against the disc. When braking is completed and the pressurization relaxed, the friction members return to their original positions.

In any braking action the contact between stationary and rotating components produces heat. In the instance of drum brakes, this heat is trapped within the drum, and constant or "hard" braking results in a loss of braking power known as "brake fade." One of the chief advantages of disc brakes is that they permit rapid and relatively unhampered dissipation of heat, thereby reducing the incidence of brake fade. One witness in this case testified that a disc brake is a mechanism which converts the kinetic energy of a moving body into heat and then dissipates that heat. The particular disc brake assemblies involved in this appeal are referred to as "fixed caliper" brake assemblies. The term "caliper" refers to the housing of the brake. Both in '516 and '650 and in the accused Kelsey-Hayes brake the caliper or housing is stationary and the movement, which occurs when braking is initiated, is confined to the pistons, the friction elements, and their backings. There are, therefore, a number of similarities between the

patented Dunlop brakes and the accused Kelsey-Hayes device in terms of design and operation.

The '516 Patent

The District Court held the '516 patent invalid, and we will consider this issue first. Kelsey-Hayes, in its answer, asserted that the patents in suit are invalid under the provisions of 35 U.S.C. §§ 102(a), 102(b), and 102(g), which read as follows:

> **§ 102. Conditions for patentability; novelty and loss of right to patent**
>
> A person shall be entitled to a patent unless—
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or
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> (g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it. In determining priority of invention there shall be considered not only the respective dates of conception and reduction to practice of the invention, but also the reasonable diligence of one who was first to conceive and last to reduce to practice, from a time prior to conception by the other. July 19, 1952, c. 950, § 1, 66 Stat. 797.

The holding of invalidity with respect to the '516 patent is based on the "Goodyear evidence." The testimony of

witnesses produced by Kelsey-Hayes and accepted by the District Court was that just a few days after it had signed the sublicensing agreement with Bendix, Kelsey-Hayes learned from Ford Motor Company that Goodyear had engaged in considerable activity with respect to fixed caliper disc brakes for vehicles other than aircraft in the period immediately after World War II. The evidence revealed that in the year 1943 Jesse Hawley, an inventor with several patents to his credit, constructed a fixed caliper disc brake which he installed on a 1941 Ford. At this time he was involved in design work for Goodyear Aircraft and he licensed Goodyear under all of his brake designs, other than those for aircraft, and sold the Ford automobile equipped with his disc brakes to Goodyear. There is a marked similarity both in design and function between the Hawley disc brake, the Dunlop '516 brake and the accused Kelsey-Hayes brake. In addition to the brake mounted on the 1941 Ford, Goodyear constructed at least three other disc brakes from the same basic design. One was installed on a radar trailer manufactured by Brooks and Perkins for Bell Telephone Laboratories; one was manufactured as a helicopter rotor brake and sold to Sikorsky Aircraft and one was installed by United Aircraft as a wind tunnel brake.

A number of witnesses testified concerning the Goodyear activity in non-aircraft disc brakes. These included employees of Goodyear during the period when the brakes were constructed and sold as well as employees of the purchasing companies. Detailed drawings of the original Hawley brake and the subsequently produced brakes embodying the same basic principles and design were introduced along with several photographs. The secretary of Goodyear testified that in the late 1940's as assistant secretary he was involved in Goodyear's purchase of the Hawley 1941 Ford equipped with fixed caliper disc brakes. An engineering specialist with Goodyear testified that he was familiar with the first automotive disc brake built by

Goodyear on the Hawley design. He testified that standard auto brake tests were conducted on the Ford equipped with these brakes and that it was taken to Sideling Hill, Pennsylvania and left for a week of tests. He further testified that the car was taken by Goodyear to Detroit in 1945 and left with Ford Motor Company for two or three days of testing. This witness stated that he drove the Ford equipped with the Hawley brakes many times, using it for routine transportation and that the brakes were quite satisfactory and he did not experience the "fade" of drum brakes. He testified that Goodyear kept the car for about three years before selling it and that it was used extensively and publicly in that time.

The former manager of the Wheel and Brake Division of Goodyear testified that he recalled the Hawley disc brake which was mounted on the 1941 Ford. He stated that this brake was demonstrated to at least four automobile manufacturers, none of whom was persuaded to switch to disc brakes. He testified that he thought the brake performed better than existing drum brakes, but that at the particular time (1946) there was such great demand for automobiles produced in Detroit that there was no inclination among the major manufacturers to make a change in basic equipment such as this. This witness described the Hawley brake in great detail and showed a familiarity with its design and operation. He introduced as an exhibit a report dated July 7, 1949 which was a resumé of the testing of Goodyear's single disc brakes on automobiles. This report described not only the original Hawley brake but several variations which were designed and constructed by Goodyear and then tested on a fleet of cars at the Goodyear plant.

Another witness produced by Kelsey-Hayes was a former Goodyear engineer in charge of the development and test work on automotive disc brakes. In addition to identifying the Hawley disc brake and testifying that he drove the

automobile equipped with this brake many times with satisfactory results, he also described improvements to the brake which were developed by Goodyear. He referred particularly to another fixed housing brake which was shown by pictures in the resumé previously referred to and which was mounted on a 1946 Ford. He testified that this was basically the same as the Hawley brake, with opposed pistons which moved laterally and fixed cylinders which were bolted to the housng or calipers. He stated that this brake unit was subjected to comprehensive tests on the 1946 Ford and that there were no difficulties in normal operations. On excessively rough roads, problems were experienced with this brake, but it was his opinion that this could have been corrected by rearranging the hydraulic system. The brake had an automatic adjusting feature which was not present in the original Hawley model. The witness also identified a set of brakes that was made for Brooks and Perkins Company of Detroit. These brakes were mounted on a radar trailer manufactured for Bell Telephone Laboratories. He stated that aside from the automatic adjuster it was a similar brake to the original Hawley brake. It had two pistons on each side of the disc compared to single pistons which were used on automobile brakes. He testified that the design work for the Brooks and Perkins brake was done in 1948 and that the brakes were produced in 1949. The trailer for which these brakes were manufactured was designed to carry electronic equipment used in the Nike missile program and was part of a government contract. The witness saw the brakes attached to the trailer, but did not know exactly how many sets of these brakes were actually sold. He said that he was the designer of the brake and that it was never patented.

Although there were indications that the Brooks and Perkins trailer was classified "restricted" by the military, the witness could not recall any particular security restrictions which were imposed while the brakes were being produced for the trailer. It was the opinion of at least

one of the witnesses that only the electronic equipment was restricted and that this classification did not extend to such equipment as wheels and brakes on the trailer. In this connection, a question was raised about an outside shield which was installed around this brake and it was testified that the purpose of this shield was to protect the brake when the trailer was floated in water. One of the specifications for the trailer was that it was required to float for a certain period of time. A trial witness observed a test of the trailer in the Detroit River and stated that the shield performed well and that no water leaked into the brake assembly. Other former Goodyear employees identified detailed drawings of the Hawley-type brakes made for Sikorsky Aircraft for its helicopter rotors and one built for United Aircraft as a wind tunnel brake. Sales records were produced which authenticated the sales of these brakes by Goodyear.

Dunlop maintains that the Goodyear activity does not qualify, for a number of reasons, as prior art under 35 U.S.C. § 102. Instead, Dunlop would classify the Goodyear activity as "paper" prior art, which was never actually reduced to practice by successful testing. It hinges its entire case with respect to the validity of '516 on the proposition that the District Court erred as a matter of law in holding that the Goodyear uses invalidated this patent without a finding of fact that there had been an actual reduction to practice by successful testing. In *National Latex Products Co.* v. *Sun Rubber Co.*, 274 F.2d 224 (6th Cir.), *cert. denied* 362 U.S. 989 (1960), this Court held that one claiming that a patent is void because it has been anticipated by prior art in the field carries a heavy burden and that proof of prior knowledge and use must be "clear and satisfactory." *Id.*, at 231. The opinion emphasizes that prior art should be established by more than oral testimony and that reduction to practice is an essential if prior art is to be held to anticipate a patent. However, the case does not establish a requirement of *successful* testing as contended by Dunlop.

The fact that a device has imperfections and encounters commercial problems does not disqualify it as anticipating prior art. While pointing out that a machine might qualify as prior art even though inoperative, the Court of Appeals for the Seventh Circuit stated: "So long as it embodies the same construction and principle as the alleged invention, a structure is effective as prior art even though the construction of the machine is crude, or the machine is imperfect in operation." *Sutter Products* v. *Pettibone Mulliken Corp.*, 428 F.2d 639, 647 (7th Cir. 1970).

The requirement of 35 U.S.C. § 102(b) is that there has been a public use or sale of the invention in this country more than one year prior to the date of the patent application, and the alleged infringer must show this fact by clear and convincing evidence. *Minnesota Mining & Mfg. Co.* v. *Kent Industries, Inc.*, 409 F.2d 99 (6th Cir. 1969). A single public use or a mere placing of the invention on sale meets the requirements of the statute. In *F. M. C. Corporation* v. *F. E. Myers & Bro. Co.*, 384 F.2d 4 (6th Cir. 1967), *cert. denied* 390 U.S. 988 (1968), "public use" was defined as "any non-secret use of a completed and operative invention in its natural and intended way." 384 F.2d at 9. A prior use which is substantially for experimental purposes does not invalidate a later patent. *Minnesota Mining & Mfg. Co.* v. *Kent Industries, Inc., supra.* A prior device need not be patented in order to anticipate, and if it has been reduced to practice, even though it is abandoned later, it may negative novelty in a subsequent patent. *Monroe Auto Equipment Co.* v. *Heckethorn Mfg. & Supply Co.*, 332 F.2d 406 (6th Cir.), *cert. denied* 379 U.S. 888 (1964). The statute speaks in terms of sales and use of the prior device and no testing requirement, as such, is listed. There was testimony that the original Hawley brake on the 1941 Ford was tested and similarly that some testing took place on the Hawley-type brake installed on the 1946 Ford by Goodyear and on the brakes built for Brooks and Perkins, Sikorsky and United Aircraft. A read-

ing of Dunlop's brief reveals that the type of testing it maintains should be required is something comparable to the highway safety standards promulgated by the Department of Transportation. Such testing might well be required before any automobile part were mass produced and affixed to vehicles offered for sale to the public generally, but the requirement that prior art be reduced to practice does not entail this degree of perfection. The total effect of Dunlop's arguments with respect to the Goodyear evidence is that Goodyear engaged only in experimental work with fixed caliper automotive disc brakes and that there was no successful reduction to practice of this concept by Goodyear.

Every patent issued by the United States Patent Office carries with it a presumption of validity. 35 U.S.C. § 282. However, where applicable prior art has not been considered by the Patent Office this presumption is greatly weakened. *Aluminum Company of America* v. *Sperry Products, Inc.*, 285 F.2d 911 (6th Cir. 1960), *cert. denied*, 368 U.S. 890 (1961). In *F.M.C. Corporation* v. *F. E. Myers & Bro. Co., supra.*, we held that when an alleged infringer makes a prima facie demonstration of prior use, the inventor then has the burden of proving that this use "was not of a functionally operative device, or was substantially used for experimentation or testing purpose." 384 F.2d at 10. The evidence of the Goodyear activity in fixed caliper disc brakes was sufficient to make a prima facie case of anticipation by prior use. The evidence of Dunlop, to the contrary, fell short of that required to rebut this showing. The novelty required by 35 U.S.C. § 102(a) is lacking where there has been anticipation by an earlier device, whether patented or not, where all the elements of the patent, doing substantially the same work in the same way are found in a single prior art structure. *A. J. Industries, Inc.* v. *Dayton Steel Foundry Co.*, 394 F.2d 357 (6th Cir. 1968). In his findings of fact with respect to the validity of '516 patent, Judge Pratt held that each of the four Hawley-type disc brakes manufactured by Goodyear was substantially

identical to the claims of the '516 brake of Dunlop; that each of the brakes was sold and that each was successfully operated for a period of time. He also found that the use of the Goodyear brakes was public and that the brakes were not merely experimental but should more accurately be classified as "custom built." The Court also made a specific finding that the evidence of Goodyear disc brake activity was not considered by the Patent Office prior to the issuance of the '516 patent.

There was introduced into evidence a letter written on May 13, 1964 from the general manager of Dunlop's brake division to an attorney for Kelsey-Hayes. This was after Kelsey-Hayes had discovered the existence of the previous Goodyear activity and had determined to cancel its sublicense from Bendix and proceed with the production of fixed caliper disc brakes without royalty payments to Bendix or Dunlop. This letter indicated considerable doubt by Dunlop concerning the validity of the '516 patent but disclosed an intention to bring infringement actions for commercial advantage. The relevant portion of the letter is as follows:

> "The reports from our attorneys are in fact very much as we expected them to be. Considerable doubt is expressed as to the validity of No. 2,790,516 in view of the Goodyear disclosures. However, it also seems the case that most of the evidence on which an opponent might have to rely has been destroyed or is no longer available and whilst we think that we would be reluctant to litigate this patent we would not like you to assume that in no circumstances would we fail to do so. On the contrary it could well be of advantage to us, commercially, to start an action for infringement."

The findings of fact of the District Court with respect to the validity of the '516 patent are supported by competent evidence and are not clearly erroneous. Having

found that the Goodyear devices constitute prior art and were known or used by others in this country, that the uses were public and not secret or purely experimental, the Court properly concluded that the claims of the '516 patent had been anticipated and that it was not a patentable invention under 35 U.S.C. § 102(a), (b) or (g). Our holding that the '516 patent is invalid dispenses with the need for consideration of the infringement issue. *Felburn* v. *New York Railroad Co.*, 350 F.2d 416 (6th Cir. 1965), *cert. denied*, 383 U.S. 935 (1966); *National Transformer Corp.* v. *France Mfg. Co.*, 215 F.2d 343 (6th Cir. 1954).

The '650 Patent

As has been earlier pointed out, the '650 patent is also a fixed caliper, opposing piston disc brake. However, it was designed specifically for railroad cars and heavy industrial equipment. Claim 13 of the patent application deals with a feature for the removal of the friction pads. Since the entire controversy concerning the validity of the '650 patent revolves around Claim 13 it is set forth verbatim. Claim 13 of the '650 patent reads as follows:

> "A disc brake comprising a rotatable disc; a pair of friction elements, one on each side of said disc and covering only a portion of the braking surfaces of said disc, each of said elements having end portions transverse to the direction of movement of the disc and providing bearing surfaces on which said elements are slidably supported; a stationary torque-resisting member having at least three components holding said friction elements from movement in a plane parallel to said disc, and at least one of said components being displaceable to permit removal of said friction elements in a plane parallel to said disc and a pair of said components being held in axially spaced positions on each side of and closely spaced from said disc and having surfaces transverse to the

direction of rotation of said disc and placed complementarily to the transverse end portions of said friction elements to guide said elements at their opposite ends in movement to and from said disc and to restrain said elements from circumferential movement parallel with said disc; and means to move said friction elements toward said disc, each of said friction elements being between said means and said disc."

Kelsey-Hayes bases its attack on the '650 patent in part on an assertion that the invention was not patentable because of obviousness under 35 U.S.C. § 103 and the claim that the specification of the patent does not comply with the requirements of 35 U.S.C. § 112. Section 103 provides as follows:

§ 103. Conditions for patentability; non-obvious subject matter

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made. July 19, 1952, c. 950, § 1, 66 Stat. 798.

The '650 brake provides a means for removing friction elements and replacing them. This is important because these friction pads wear out more quickly than the other components of the brake, and a quick and inexpensive method of replacing worn pads is a desirable feature of any disc brake. While this need was obvious, the method by which it was met in the '650 patent was not obvious within the meaning of § 103, and the District Court correctly held that it did not lack patentability for obviousness.

The more serious attack by Kelsey-Hayes on the '650 patent concerns the language of Claim 13 and the late filing of that Claim. Claim 13 was not added to Dunlop's application for the '650 patent until more than five years after the original application. Kelsey-Hayes asserts that the language of Claim 13 is purposely vague and indefinite in an attempt to cover brakes of other manufacturers already on the market. It particularly attacks the language of Claim 13 which refers to a ". . . stationary torque-resisting member having at least *three components* holding said friction elements from movement in a plane parallel to said disc, and at least one of said components being displaceable to permit removal of said friction elements in a plane parallel to said disc and a *pair of said components* being held in axially spaced positions on each side of and closely spaced from said disc. . . ." (emphasis added). It is claimed that the evidence at the trial showed that no pair of components is held in axially spaced positions on opposite sides of the disc and that the use of the word "components" was contrived to be broadly enough defined to cover dissimilar elements of other devices.

There was a great deal of discussion by the witnesses and attorneys of the meaning of the word "components" and whether it is synonymous with "elements." Kelsey-Hayes makes much of the fact that the expert witness who testified for Dunlop designated four components whereas an answer to interrogatories and the file history of the patent identified three components. In upholding the validity of the '650 patent, the District Court decided this battle of semantics by finding that "the essence of the invention is the provision for a displaceable member which is a working portion of the caliper and is integral to the torque-taking function, but allows the removal of an end piece which does not disturb the power sides of the unit. . . ." The Court reached this conclusion by examining the language of the Claim itself. The Claim describes a stationary torque-resisting member having at least three components, at least one of which is displaceable to permit removal

of the friction elements in a plane parallel to the disc and a pair of "said components" being held in axially spaced positions on each side of and closely spaced from the disc. The displaceable portion of the brake assembly is a component of the fixed housing. A comparison of this language with the specification and the preferred form leads to the conclusion that the only members which could provide the surfaces described in Claim 13 and perform the functions called for therein would be the limb portions of the two ends of the caliper, one of which is the displaceable end. This restrictive reading of the scope of Claim 13 also led the Court to the conclusion that the original disclosure of the application would permit the addition of Claim 13 as against the contention of Kelsey-Hayes that the patent is invalid under the "late claiming" doctrine. In *Muncie Gear Works, Inc.* v. *Outboard Marine & Manufacturing Co.*, 315 U.S. 759 (1942), the Supreme Court held that a late claim filed more than one year after public use of an invention does not invalidate the original application if it only clarifies matter sufficiently disclosed in the original application. As interpreted by the District Court Claim 13 related to matters fully disclosed in the original application. *Coats Loaders & Stackers, Inc.* v. *Henderson*, 233 F.2d 915, 924 (6th Cir. 1956).

The restrictive reading which the Court gave to Claim 13 compelled the further finding that the accused device of Kelsey-Hayes does not infringe '650. It is difficult to compare the two brakes since '650 was designed for railroad rolling stock and other heavy industrial uses and the accused brake of Kelsey-Hayes is a disc brake assembly for automobiles. Removal of the friction elements from the Kelsey-Hayes brake is accomplished in quite a different manner from that of the '650 brake. Rather than having a portion of one arm of the fixed caliper made displaceable for purposes of removing friction pads circumferentially, the Kelsey-Hayes brake is equipped with spring clips attached to the housing, and unscrewing these spring clips

permits the friction pads to be withdrawn radially. Although Dunlop's expert witness attempted to find in the Kelsey-Hayes brake elements which corresponded with each of the "components" set forth in Claim 13, certain important differences between the two devices could not be overlooked. A patent is infringed when a comparison between it and an accused device reveals that every element of the claim alleged to be infringed is found in the accused device and that both perform "substantially the same function in substantially the same way to obtain the same results." *F.M.C. Corporation* v. *F. E. Myers & Bro. Co., supra* at 14.

The District Court made the following four findings of fact with respect to infringement of the '650 patent, all of which are supported by competent evidence:

> 1. The accused brake method includes the displacement of two spring clips on top of the housing but not integral to the housing, which spring clips serve a torque-taking function in a radially outward direction, a minor, if not minimal, torque action created by the rotation of the disc.
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> 2. The accused brake uses the ends of the caliper as guiding and torque-taking surfaces similar generally to the use of the ends of the '650 caliper.
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> 3. The friction members of the accused brake have backing plates which are elongated and which have, on the top ends, ears which fit into and ride on ledges formed into the ends or bridge pieces of the caliper. The ears are held down by the spring clips which are attached to the caliper ends by screws.
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> 4. The accused brake is entirely open on the top and the friction pads may be removed by unscrewing the spring clips from the caliper. The pads are thus removed radially and outwardly in a plane parallel to the disc.

In discussing the "distinctive contrasts" between the '650 brake and the accused Kelsey-Hayes device, the District Judge pinpointed the difference in the identity and function of the displaceable members of the two brakes in the following language: "Most importantly, in the '650 patent the removal requires the displacement of an integral end of the caliper, the predominant torque-taking device, whereas in the accused brake, removal requires the displacement of two spring clips which serve little torque-taking function. The clips are attached to, but not integral to the top of the caliper." We agree that this is a real distinction between the two brakes. Certainly the principal of a disc brake assembly having a displaceable member to provide for the removal of worn friction pads is not in itself patentable. Having necessarily confined itself to a particular application of this principle Dunlop cannot successfully claim infringement against a brake which achieves this result in a different manner.

We are not unaware of the fact that during the period of time that Kelsey-Hayes was a sublicensee of Bendix, the licensee of Dunlop, there was an exchange of information between Dunlop and Kelsey-Hayes relating to fixed caliper disc brakes for automobiles. Nevertheless, upon learning of the Goodyear activity, Kelsey-Hayes expressed its dissatisfaction with the sublicensing agreement a few days after it was signed. A period of time passed in which negotiations were carried on between Dunlop and Kelsey-Hayes looking toward a possible settlement of the dispute, but they were not successful. Upon being advised by Dunlop during this period of time that it was sending certain information to Kelsey-Hayes which it considered confidential, Kelsey-Hayes immediately directed Dunlop not to send the material. The record indicates that both parties considered it to be advantageous to their interests to maintain close contact with each other during the period before the final break which led to this law suit.

The District court corectly held that the '650 patent is valid and that Kelsey-Hayes has not been guilty of infringement with respect to it.

The Kelsey-Hayes Cross-Appeal

Kelsey-Hayes sought treble damages for alleged violation of the antitrust laws of the United States in certain actions of Dunlop. It is alleged that various foreign licenses of Dunlop which forbid exportation of the Dunlop brakes from the foreign manufacturers to the United States constitute an illegal division of world markets. The case cited by Kelsey-Hayes, *United States* v. *Topco Associates*, 405 U.S. 596 (1972), is not in point. That case involved a horizontal agreement dividing markets within the United States. Dunlop's agreements with its licensees in Japan, Italy, Germany and Australia cannot be characterized as true horizontal agreements dividing markets. They are merely territorial licenses granted by a patentee such as are permitted by 35 U.S.C. § 261. If one who received a patent from the United States may so restrict his licenses without violating the domestic antitrust laws, it would seem clear that a patentee could do the same thing with foreign licenses without violating the antitrust laws of this country. Kelsey-Hayes also cited *Krampe* v. *Ideal Industries, Inc.*, 347 F. Supp. 1384 (N.D. Ill. 1972). In that case misuse of a patent was found to exist because the licensing agreement required the licensee to sell no other products which were similar or identical to the patented device. The fact that this prohibition might limit commerce in the patented device between Germany and the United States was a purely incidental consideration in the holding of the Court.

Referring to the letter from Dunlop management to Kelsey-Hayes counsel in which doubts were expressed about the validity of the '516 patent, Kelsey-Hayes alleged a misuse of the patent in Dunlop's efforts to license it after having doubts about its validity. It also claims that

Dunlop, knowing the '516 patent was invalid, nevertheless attempted to persuade Kelsey-Hayes to pay royalties under the '516 patent in order to obtain a license to manufacture other Dunlop brakes in the United States. These charges of misuse of the patent are not supported by evidence of probative value, and the District Court corectly held that Kelsey-Hayes had not established misuse.

Other allegations of unclean hands were made by Kelsey-Hayes in support of its demand for attorney's fees in this action. In his Memorandum, Judge Pratt noted that both sides indulged in innuendo and sought to create inferences of inequitable conduct by the other party. However, hard proof of any misconduct on the part of either plaintiff or defendant is lacking, and Kelsey-Hayes simply failed in its burden of proving the allegations.

Our conclusion from studying the entire record in this case, which record is lengthy and in many respects obfuscated, is that Judge Pratt displayed a clear understanding of the mechanical principles as well as the legal issues involved and that his findings and conclusions are correct.

The judgment of the District Court is affirmed.

APPENDIX B

Memorandum Opinion of the United States District Court for the Eastern District of Michigan, Southern Division (May 15, 1972)

This is a patent infringement suit brought by the plaintiff, The Dunlop Company, Limited, a British company located in London, England, against the defendant, Kelsey-Hayes Company, a Delaware corporation, located in Romulus, Michigan.

The plaintiff is the owner of the four patents in suit--Nos. 2,790,516, Reissue 24,879, 2,921,650 and 3,392,809—(hereinafter referred to by the last three digits of each

patent number) all of which relate to vehicle disc brakes. Plaintiff contends that disc brakes manufactured and sold by defendant infringe various claims of these respective patents and seeks injunctive relief and an accounting for damages.

The defendant is a manufacturer of automotive parts, including brakes, and the disc brakes in issue here are those supplied to the Ford Motor Company. Defendant denies infringement, asserts the invalidity of each of the patents and also claims the patents are unenforceable because of plaintiff's misuse thereof and because of other improper and inequitable conduct.

The parties have stipulated that the Court has jurisdiction of the parties and the subject matter and the Court so concludes.

Sometime prior to World War II, the usual, if not universal vehicle stopping device was a "drum brake," whose principle was the application of friction members, commonly called "brake shoes" against the inner periphery of a drum which was a part of the wheel assembly. The exigencies of stopping large aircraft inspired the development of disc brakes for that purpose and several manufacturers, including the plaintiff and Goodyear Tire and Rubber Company, were major suppliers of aircraft disc brakes.

The drum brake has a critical fault. The application of the brake shoes to the periphery of the rotating drum creates heat which can be dissipated only through the drum itself and then into the atmosphere. The high temperatures resulted in the loosening of the brake shoes and caused a loss of breaking power, customarily called "brake fade."

The disc brakes alleviates, by its design and structuring, this problem of heat retention and permits the heat to dissipate directly into the atmosphere. In principle, the disc brake is composed of a disc and a brake housing or caliper. The disc is attached to the wheel and rotates with it. The

housing is fixed to the car assembly and straddles a portion only of a disc. The application of the brake pedal causes hydraulic to pressure pistons against friction members located in limb or side of the housing, forcing these friction members to "pinch" the revolving disc. Simplisticly, one can demonstrate the principle by rolling a coin along a desk top and pinching the coin between thumb and forefinger as it is rolling. The resulting exposure of most of the disc and the relatively small friction members permits quick and comparatively unhampered heat dissipation into the atmosphere and presents the major advantage of the disc brakes over the drum brake.

The end of World War II and the cut-back in aircraft production with concomitant increase in automotive production saw more attention being focused on the development of a disc brake suitable for vehicles other than aircraft. Although the principle of disc brakes was established, the application made to aircraft was not readily adaptable to automotive vehicles, obviously a huge market.

As is indicated by the file and records of this suit, various organizations and individuals became engaged in the development of automotive disc brakes, including the plaintiff Dunlop. It obtained patents, including the patents in suit, and inceptively used as a major testing and promotional arena the sports car racing circuit on the Continent, first with the Jaguar automobiles and later with an increasing number of other European automobiles. Plaintiff granted licenses under its patents to firms in several countries and in 1956 licensed Bendix Corporation under the first three patents in suit as its exclusive licensee in the United States. Despite the growing acceptance of disc brakes on the Continent and elsewhere, the American automotive industry, while evidencing interest and conducting its own research in disc brakes, was not enthusiastic. The extent of Bendix commercialization of its license was limited to one Studebaker model.

In January, 1961, the General Manager of plaintiff's Brake Division gave a talk on disc brakes to a convention of engineers in Detroit. This honed the interest of the defendant, a manufacturer of drum brakes, and contact was made with plaintiff. This contact continued during late 1961 and through 1962 and 1963 and included visits by defendant's engineers to plaintiff's plants in England and the release of technical information and advice by plaintiff to defendant regarding particularly the adaptation of disc brakes to the larger and differently designed American automobiles.

These discussions and conferences culminated in Bendix, the exclusive Dunlop licensee in the United States, granting to the defendant a sublicense under the three fixed caliper patents in suit in July, 1963. Shortly after the sublicense agreement, the defendant learned of certain prior Goodyear activity in the disc brake area and this activity was investigated by both plaintiff and defendant.

The Goodyear activity, more of which will be described below, raised questions regarding the validity of the plaintiff's fixed caliper patents and, when negotiations eventually proved fruitless, resulted in the termination of the sublicense January 1, 1966.

The '516 Patent

The '516 patent was issued to plaintiff by the United States Patent Office on April 30, 1957. It is of the fixed caliper (housing and caliper are used interchangeably in the trade) type with the caliper straddling a portion of the disc. The caliper is bolted to stationary part of the vehicle assembly while the disc is affixed to the wheel assembly (axle or stub axle) and rotates with it. Roughly, the caliper is in the form of an arch or "U" and can be generally described as two limbs and a bridge piece. The two limbs are adjacent to and alongside of the disc, while the bridge piece is outside of the rim of the disc, much like the coin

and finger demonstration above. Each limb contains at least one bore or cylinder into which fit pistons and friction pads. Hydraulic fluid pressure forces the pistons against the pads, which are, in turn, forced against the rotating disc and pinch the disc to a stop. Since the disc is attached to the wheel assembly, this, of course, causes the wheel to stop rotating also.

Validity of '516 Patent

The defendant has challenged the validity of the '516 patent, the basis of the challenge being the prior Goodyear Tire Company activity. Defendant points to four alleged sales of Goodyear disc brakes as constituting prior art in anticipation of the plaintiff's '516 brake. The plaintiff contends that the four alleged sales are not, in fact and in law, the types of sales which fulfill the prior art criterion so as to invalidate the '516 patent.

With respect, then, to this issue, the Court makes the following specific findings of fact.

1. The Goodyear PD 1018-1 disc brakes (the radar trailer brakes) are substantially identical to the brake claimed in the '516 patent. The fact that a shield was installed over the unit for purposes of meeting the Army Ordinance water-tight specifications does not affect the design of the unit itself. The fact that the friction members may not have been separate from the pistons is a minimal consideration and an obvious construction.

2. The Goodyear PD 1018-1 disc brakes were manufactured and sold by Goodyear Tire Company in 1949 for use on radar trailers built by Brooks and Perkins Company of Detroit, Michigan and Douglas Aircraft Company of California.

3. The two radar trailers were built pursuant to government contract for the purpose of housing radar equipment to provide mobility for radar units and were designed to be pulled by a truck.

4. Disc brakes were installed on both trailers and the trailers subsequently were sold and delivered to the Army Ordinance Department.

5. The disc brakes were tested to some extent and were not found to be unsatisfactory, but were replaced by electric brakes on the requirement of Army Ordinance. There is no indication that the replacement was occasioned by the performance of the disc brakes but rather for other reasons.

6. The mobile radar trailer project was classified "Restricted" by Ordinance authorities. Despite that classification no meaningful attempts were made to comply with it with regard to the disc brakes and other parts of the trailer fabrication. Rather, it was considered that the confidential aspect of the project was the radar equipment to be placed in the trailer. This is evidenced by the lack of any precautionary measures, for example, in the manufacturing of the brakes, the fabrication of the trailer, the installation of the brakes, the public testing of the trailer after brake installation as to its water-tightness and the transport of the completed trailer (prior to installation of radar equipment) from Detroit to New Jersey on an open, flat-bed railroad car.

7. While the Goodyear 1018-1 brake manufacture was a special project at Goodyear, there being no constant market for disc brakes, the indicia that would establish that it was an experimental model, or create inferences to that effect, are lacking. The appearance is much more closely akin to a "custom job" than to prototype development.

8. The Goodyear PD 1018-F (Hawley) disc brake is substantially identical to the brake claimed in the '516 patent. Again the fact that the friction pads may have been connected to the pistons does not materially affect the anticipation.

9. The Hawley brake was designed by one Jesse G. Hawley, and on October 24, 1944, a 1941 Ford coupe equipped

with the Hawley disc brake was sold to Goodyear. Hawley had a working relationship with Goodyear and the agreement, which included the sale of the Ford coupe, contains provisions regarding development of disc brakes in other than the airplant field, royalty and licensing, patent prosecution and the like.

10. The Hawley disc brakes as installed on the Ford coupe were demonstrated to various automobile manufacturers and the coupe was used by Goodyear engineers and personnel and eventually sold to a company in Akron.

11. The Hawley disc brakes operated successfully and satisfactorily except that testing showed that driving over excessively rough roads at relatively high speeds caused a "spindle deflection." This deflection related to the disc and its mounting but the effect was to push the disc against the friction members of the caliper and, in turn, the pistons, forcing the pistons back into the cylinder and retarding the braking process.

12. Goodyear continued the development of disc brakes, including but not limited to the development of "floating" caliper to avoid the problems incident to "spindle deflection" and one of its manufactured designs in this program was the radar trailer brakes above described, which were, however, of the fixed caliper type.

13. The Goodyear PD 457 (helicopter rotor) brakes are substantially identical to the brake claimed in the '516 patent.

14. The evidence regarding the development and sale of the helicopter rotor brakes is not overwhelmingly clear. Consideration must be given, however, to the lapse of time between this project and the time of this lawsuit—almost 20 years later. On this basis, the Court is satisfied that the pertinent exhibits and testimony establishes the following related findings.

15. The Goodyear PD 457 brake was a disc brake designed to stop the rotation of the helicopter blade rotor and several were manufactured for and sold to Sikorsky Aircraft in 1949-1950 and with modification, thereafter.

16. The Goodyear PD 457 was, again, "experimental" only in that it was an adaptation of the disc brakes being developed by Goodyear to the helicopter rotor and was a customizing for a particular customer who purchased at least six of such brakes.

17. The testing indicated metal fatigue problems but did not militate against satisfactory performance and the sale to Sikorsky, who did not require testing.

18. The Goodyear PD 1055-2 (wind tunnel) brake is substantially identical to the claims of the '516 brake and was a disc brake manufactured for and sold to United Aircraft Corp. in 1950 for the purpose of braking a wind tunnel fan.

19. The wind tunnel fan brake was installed in the Spring of 1950 and operated successfully until January 3, 1952.

20. The failure occurring in January, 1952, was related to the design and milling of the *disc* rather than of the brake itself.

21. Later changes in the number of brakes, in the design of the caliper and in the design of the disc do not permit the conclusion that the PD 1055-2 disc brake was inoperative, unsuccessful, or abandoned.

22. Particular significance is given to the cumulative effect of the four examples of the Goodyear activity—all dealing with the same basic design and structure of a disc brake strikingly similar to the '516 disc brake.

23. None of the foregoing evidence of Goodyear disc brake activity was considered by the Patent Office prior to issuance of the '516 patent.

24. After receiving the opinion from its attorneys about the doubtful validity of the '516 patent and after defendant

had indicated to Bendix that it thought the '516 patent was invalid because of the Goodyear prior art disc brake situation, plaintiff's General Manager of its Brake Division wrote defendant's attorney on May 13, 1964 and stated:

> "The reports from our attorneys are in fact very much as we expected them to be. Considerable doubt is expressed as to the validity of No. 2,790,516 in view of the Goodyear disclosures. However, it also seems the case that most of the evidence on which an opponent might have to rely has been destroyed or is no longer available and whilst we think that we would be reluctant to litigate this patent we would not like you to assume that in no circumstances would we fail to do so. On the contrary it could well be of advantage to us, commercially, to start an action for infringement."

Discussion Regarding Invalidity of '516 Patent

The '516 patent does not enjoy the full presumption of validity when, as here, significant prior art was not considered. As stated in *B. F. Goodrich Co.* v. *Rubber Latex Products, Inc.*, 400 F.2d 401, 405 (6th Cir., 1968):

> "Although 35 U.S.C. § 282 creates a presumption that a patent is valid, it has long been held in this and other circuits that this presumption is weakened and largely dissipated when pertinent prior art, . . . was not considered by the Patent Office during processing of the patent in suit." (Citations Omitted).

See also *Westwood Chemical, Inc.* v. *Owens-Corning Fiberglass Corp.*, 445 F.2d 911, 916 (6th Cir., 1971), cert. den. 40 LW 3399 (2-22-72).

It cannot be seriously argued that the Goodyear devices which constitute the prior art were not "known or used by others in this country." 35 U.S.C. 102(a). The evidence indicates that the devices were used on a variety

of jobs for a variety of purposes several years before plaintiff's first claiming date. In the case of the '516 patent, that date is January 22, 1951. *Kaiser Industries, Inc.* v. *McLouth Steel Corp.*, 400 F.2d 36, 42 (6th Cir., 1968), cert. den. 393 U.S. 1119; 35 U.S.C. §§ 104 and 119.

It is immaterial that the Goodyear brakes were not all automobile brakes. They were used in an analogous art for an analogous purpose. *Gates Iron Workers* v. *Fraser*, 153 U.S. 332 (1894).

Nor is the fact that a device may be hidden from sight, as in the auto, sufficient to avoid anticipation. *Brush* v. *Condit*, 132 U.S. 39, 49 (1889).

Extended use is not a requirement. One or two successful applications to use are sufficient. *Miller* v. *Foree*, 9 F. 603 (6th Cir., 1881), affirmed 116 U.S. 22.

Plaintiff's argument that the Goodyear devices were inoperative and therefore disqualified as prior art is not persuasive. A similar argument was rejected by the Court in *Sutter Products Co.* v. *Pettibone Mulliken Corp.*, 428 F.2d 639, 646-647 (7th Cir., 1970):

> "Inefficiency, even to the point of practical ineffectiveness, does not necessarily invalidate an invention as prior art in all its aspects. Dalin v. Watson, *supra*, 204 F.2d at p. 732. So long as it embodies the same construction and principle as the alleged invention, a structure is effective as prior art even though the construction of the machine is crude, or the machine is imperfect in operation. Zephyr American Corporation v. Bates Mfg. Co., 128 F.2d 380, 385 (3rd Cir., 1942)."

Though they were not perfect, the Goodyear devices achieved the desired results. Successful testing is not a necessity. *Hall* v. *MacNeale*, 107 U.S. 90 (1883).

Plaintiff contends that *Piet* v. *United States*, 176 F.Supp. 576 (S.D. Cal., 1959), modified on other grounds 283 F.2d

693, stands only for the proposition that an inventor may not lengthen his monopoly by sale of his invention into a restricted use, and that *Technitrol, Inc.* v. *Aladdin, Inc.*, 316 F.Supp. (N.D. Ill., 1970) stands for the proposition that sale by one other than the inventor into a restricted use disqualifies the invention as prior art. Even assuming that these contentions are legally correct, they are not supported by the facts in the instant case.

The issue of whether a use of a device is experimental or public is one of fact. *McCullough Tool* v. *Well Surveys, Inc.*, 343 F.2d 381, 394 (10th Cir., 1965), certiorari denied 383 U.S. 933, rehearing denied 384 U.S. 947. So too, the question of whether a use is secret is one of fact. *Huszar* v. *Cincinnati Chemical Works*, 172 F.2d 6 (6th Cir., 1949). In the instant case the Court found as a matter of fact that the use of the radar trailer brake was not a restricted use.

Conclusion of Law Regarding Validity of '516 Patent

The Goodyear activity, which predates the filing date of the '516 patent, constitutes prior art and invalidates the claim in suit of the '516 patent under 35 U.S.C. 102(a)(b) or (g).

Infringement of Patent '516

While a general and simplistic description of the '516 patent was given previously, it is necessary to analyze carefully the claim language of the patent in dispute here. Specific findings below follow serially the previous findings.

1. Claim 1 of the '516 patent in suit reads as follows:

> "A disc brake assembly comprising a disc engaging with a rotatable member to be braked and braking means extending circumferentially over only a minor portion of the braking surfaces of the disc and comprising a nonrotatable housing having limbs extending closely adjacent each braking surface of the disc and

in fixed axial relation thereto, each such said limb having an opening in each limb forming a guide, a friction member slidable in each guide opening, the end of each guide opening having a clearance from the adjacent braking surface of the disc which remains constant throughout the wear-life of the friction member, and means for forcing each friction member into frictional engagement with the adjacent braking surface of the disc."

2. Claims 2, 3, 4, 7 and 11 of the '516 patent are directly or indirectly dependent from claim 1 and contain all of the structure called for in claim 1.

3. Claim 12 of the '516 patent, while not dependent on claim 1, is similar thereto and reads as follows:

"A disc brake assembly comprising a disc engaging with a rotatable member to be braked and braking means extending circumferentially over only a minor portion of the braking surfaces of the disc and comprising a nonrotatable housing having limbs extending adjacent each braking surface of the disc and in fixed axial relation thereto, friction members, one on each side of said disc, each movable to bring its friction surface into frictional engagement with its side of said disc, each limb providing an anchoring element extending toward the disc in position to receive adjacent said disc the anchoring thrust of its friction member, said anchoring element having a clearance from the adjacent braking surface of the disc which remains constant throughout the wear-life of the friction member, and means for forcing each friction member into frictional engagement with the adjacent braking surface of the disc."

4. All of the mechanical elements of the patent '516 claims find response in the preferred form of the invention seen in Figures 1-3 of the patent.

5. The crucial area of dispute between the parties is the interpretation of and response to the claim relating to the "limbs extending closely adjacent each braking surface of the disc and in fixed axial relation thereto" and "each limb having an opening in each limb forming a guide, or friction member slidable in each guide opening, *the end of each guide opening* having a clearance from the adjacent braking surface of the disc which remains constant throughout the wear-life of the friction member." (Emphasis supplied).

6. Claim 12 provides further dispute in the language, to wit: "each limb providing an anchoring element extending toward the disc in position to receive adjacent said disc the anchoring thrust of its friction member, *said anchoring element* having a clearance . . . which remains constant throughout the wear-life of the friction member . . ." (Emphasis supplied).

7. The embodiment of '516 shows that each limb extends closely adjacent each braking surface of the disc and that a limb contains a bore or cylinder (the singular is used for the sake of clarity but with the recognition that more than one bore or cylinder is contemplated by the claims) which is, in effect, a hollowed out portion of the limb.

8. Each bore or cylinder of the '516 embodiment contains within itself two elements—a piston and a friction pad or member.

9. The friction pad is enclosed in the cylinder, except for a small portion between the end of the cylinder and the surface of the disc and is guided in the cylinder itself.

10. Application of hydraulic fluid pressure forces the cylinder against the pad which pushes against the disc and causes the friction material to wear.

11. However, because the end of the bore or cylinder is closely adjacent to the disc surface and the friction pad is contained in the cylinder, the wearing of the friction pad

does not affect its point of support since the more the pad wears the farther the piston travels in the cylinder toward its end and the closer the back of the friction pad gets to the end of the cylinder.

12. The significance of the support is that it prevents the pad from displacement in the tendency to go in the same direction as the disc is traveling, i.e., it is a torque-taking element or anchoring element.

13. The embodiment fulfills the language of the claim regarding a guide opening and an anchoring element which is closely adjacent to the surface of the disc and remains consistent as long as the friction pad has life.

14. The significance of the constancy of the end of the guide opening and anchoring element is that it minimizes a rocking or see-saw action by the friction pad and assures even wear of the pad and fuller use of its entire surface instantaneously.

15. The accused brake also contains cylinders or bores which contain pistons activated by hydraulic pressure. However, the friction pads are not contained *within* the cylinder but ride in an opening created by the form of the housing.

16. The friction pads are elongated and semi-arcuate, and have "ears" on each top end which ride on a ledge machined or cast into the bridging portion of the housing, meanwhile obtaining guidance and anchoring support from the lower extensions of the bridging portion. The "ears" are sustained on the ledges by spring clips.

17. The pistons, therefore, when operating, extend beyond the end of the cylinder and this extension increases as the friction material wears. Concomitantly, as the friction material wears, the friction member moves along the ledge and side guides closer to the disc. The effect of this movement is to change the points of support of the friction member as the friction material wears.

18. The point of support in the accused brake varies with the wear-life of the friction material and (considering the tolerances of the trade) is, at the outset, some distance from the disc and not immediately adjacent thereto.

19. As a result of the varying of the points of support the form of the friction member and the design of the guiding and anchoring elements of the accused brake, the wear on the friction material is not even or constant as compared to the '516 brake.

20. This resulting unevenness in wear prevents instantaneous application of all the friction material to the disc and shortens the wear-life of the material.

21. The reasonable and realistic interpretation of the claims language, "each such limb having an opening in each limb forming a guide for a slidable friction member," as is indicated by the preferred embodiment, is that the "opening" is the cylinder or bore which inseparably contains both piston and friction pad, rather than an "opening" in the sense of all and any space created by virtue of a device having limbs and bridges.

22. Thus, in the accused brake, the anchoring and supporting elements occur outside of the "opening" of the limbs, and, even, to some extent on the bridging portion of the housing.

Conclusion of Law Regarding Infringement of '516 Patent

The claims in suit of the '516 patent are not infringed by the accused brake.

Discussion Regarding Non-Infringement of '516 Patent

In a discussion of the '516 patent and its alleged infringement, it is important to note that it is not the concept of disc brakes that is the issue, but rather improvements of disc brake principles that are allegedly meritorious and patentable. *Eibel Process Co.* v. *Minnesota and Ontario Paper Co.*, 261 U.S. 45 (1923).

The essence of the '516 patent is in its design that maintains guiding and anchoring elements proximately close to the disc and which provide a constant point of support to the exposed portion of the friction pad. The accused brake, by its construction, provides for the friction element to be guided and anchored at different points which change the area of support in response to the wear of the pad.

The differing areas of support result in a disadvantage which is not present in the '516 patent, that is, the misalignment of the friction element which cause a taper or uneven wear of the pad.

Much of the dispute regarding the comparison between the '516 brake and the accused brake revolved around the words "opening," "limbs" and the question of whether the '516 patent requires the inclusion of the friction member in the same or cylinder which contains the piston.

The words "opening" and "limbs" are not words of art and the experts differed as to the interpretation of those words. The Court readily admits that it is in a quandary when it comes to determining at what points in a "U" shaped structure the "limbs" begin and the "bridge piece" ends. The same may be said as to the word "opening," i.e., when do you open into an enclosure, when do you open from an enclosure out to an expanse. It appears to be prudent, then, to look to the function that is to be performed, and reviewing the specifications of the patent, determine the scope of the claimed improvement.

Using such an approach, the teaching of the '516 patent emphasizes the inclusion of friction element and piston in the same bore or cylinder with the resultant advantages of a constant point of support, and an immutable guide.

To put simply, the '516 patent is limited by its terms to an opening in the limbs and does not apply to the opening formed *by* the limbs or by the indispensable presence of the limbs.

The '870 Patent

The '870 patent is a reissue patent based on the '516 patent. It is also of the fixed caliper type but included certain improvements. These improvements were a universal pivoting connection between the piston and the friction element which permitted the friction element to adjust itself to variations of the disc and features which facilitated replacement of worn friction members. Another of the advantages of the connection feature was a more effective way of dissipating the heat caused by the friction process.

Validity of '870 Patent

The defendant's attack on the validity of the '870 patent is primarily limited to the feature of the "universal pivoting" connection between the piston and the backing plate of the friction member.

The basis for defendant's claim of invalidity as to claim 9 of the '870 patent is that the language of the claim is overly broad and is not clear and definite as required by the statute. In that context, the defendant asserts that Figure 1 of the patent describes an entirely different concept than does Figure 5, which is the preferred form relied upon by plaintiff in this case, and that if in fact the broad and indefinite language of the claim does adequately cover Figure 5, the claim is invalid over the prior art of the '516 patent. The plaintiff contends that while Figure 1 and Figure 5 may differ technically, the claim language covers both drawings substantially and correctly.

With regard to this issue, the Court makes the following specific findings of fact:

1. Claim 9 of patent '870 reads as follows:

> "A disc brake comprising an annular rotatable brake disc having an annular braking surface on each side; a non-rotatable housing mounted in fixed axial position relative to said disc, said housing having a

pair of limbs one on each side of said disc and extending over a portion of the path of movement of said brakng surface and closely spaced therefrom, said housing having at least one pair of coaxial guide means with one means of each pair in each of said limbs, a friction pad for each guide means of said housing held and guided in its guide means in movement toward its respective braking surface of said brake disc; a pair of coaxial cylinders for each pair of said guide means and aligned therewith, one cylinder of each pair being detachably mounted on the outboard side of one of the limbs of said housing; and a piston for each cylinder slidable axially therein toward and from the braking surface of said disc and having a thrust element on its inboard side to abut its respective friction pad substantially centrally thereof and push said pad to frictional engagement with said disc, said thrust element including means connecting it to said friction element for universally pivoting thrust contact with said friction element whereby said pad is free to adjust itself to variations in said disc and to the wear of said pad by tilting on said thrust element as a pivot to permit limited tilting of said friction pad about the end of said thrust element and whereby said cylinder and piston may be detached from said housing free from its friction pad and displaced to permit withdrawal and replacement of said pad."

2. The '870 patent provides for "distance pieces" between the piston and the backing of the friction element. (The "backing" is a metal piece conforming generally to the size and shape of the friction material. The friction material is affixed to the backing plate and separates the material from direct contact with the piston or other pressure member.)

3. The distance pieces contemplate the serving of two functions, i.e., they provide more rapid heat dissipation and they provide a pivoting action which thereby permits

the friction pad to follow the contours or deflections of the disc. Thus, as much as possible of the pad is applied to the disc and wear of the pad is more uniform.

4. In Figure 1 of the patent, the pivoting portion of the distance piece is easily recognizable as a modification of the common "universal joint" or "ball and socket" principle.

5. The "ball and socket" type of element in Figure 1 permits the friction pad to pivot and allows it to follow readily the contours of the disc while the brake is in an operating position.

6. In Figure 5, the distance pieces are flat on the ends that abut the friction pad and do not provide a "universal pivoting" action as called for in the claims and specifications and as pictorially described in Figure 1.

7. The preferred form exemplified by Figure 5, on which plaintiff relies, reads on the prior '516 patent at the very least in so far as the "universal pivoting" action is concerned.

Conclusion of Law Regarding Invalidity of '870 Patent

Claim 9 of the '870 patent is invalid under the provisions of 35 U.S.C. 103, 112.

Discussion Regarding Invalidity of '870 Patent

The area of dispute as to the validity of Claim 9 of the '870 patent centers on the term "universal pivoting thrust contact" contained in the claim. As the Court understands it, the defendant does not contest the validity of Claim 9 as to other features involved, but asserts that Figure 5 which the plaintiff reads on the accused brake does not demonstrate a "universal pivoting" connection. The findings and this discussion are therefore limited to that issue.

This Court cannot comprehend any "universal pivoting" connection created by the flat surface of the friction braking plate and the relatively flat surface of the distance

piece as is shown in Figure 5, nor, if applied to the accused brake, between the flat backing plate and the end of the piston, even though the piston end may be slightly rounded.

Hodkinson, one of the inventors of the '809 patent in suit and the engineering staff of plaintiff, testified that he could only speculate as to the success of any universal pivoting action given the piston design of the '870 patent and that obtaining the guiding advantages along with a universal pivoting action would require changes in the design of the piston.

The credibility of plaintiff's expert on the issue suffered greatly by virtue of his testimony being at odds with the prepared chart purporting to identify and display the various elements of the claim on the particularly significant issue of the universal connection and thrust element. This expert, a patent attorney, had not prepared the chart and was not entirely familiar with what it purported to depict, such as whether it showed the brake in operation. However, the dismaying feature was not his disagreement with the chart but with his failure to advise the Court voluntarily *as* he testified that the chart did not comport with his testimony and his opinions. It should not have been necessary for the Court to interject for that purpose.

As against this, the testimony of defendant's experts, particularly the testimony of Robert Dix, who is a practicing brake engineer, was overriding in its explanation of the actual workings of the brake and the action obtained when the flat surface of the backing plate comes into contact with the surface of the end portion of the piston. That testimony fortifies a common sense response that no "universal pivoting" or "ball and socket" action occurs under such circumstances.

Infringement of '870 Reissue Patent

The two major disputes as to this issue revolve about the "universal pivoting connection" and the features re-

garding ready removal of the pistons to permit easy replacement of the friction member.

1. As to the "universal pivoting connection," the accused brake does not include "distance pieces" as contemplated by '870 patent.

2. The pistons providing the thrust element are of a piece and abut directly the backing plate of the friction member.

3. To compare separate distinct "distance pieces" to the "end of," an undefined "portion of" or "the part forward of the base of" a unitized piston is a fruitless semantic exercise.

4. The relatively flat end portions of the pistons do not provide a "pivoting" action as contemplated by the '870 patent nor does the variation caused by possible retraction differences when two or more pistons are provided on each side of a disc.

5. Further, when the brake is in actual operation, the flat surfaces of the pistons against the flat surfaces of the backing plate do not permit such "universal pivoting action."

6. The '870 reissue patent provides for a construction which facilitates replacement of worn friction members by removal of the cylinders, thus exposing or permitting easy removal of the distance pieces and the friction member, without the necessity of removing the caliper or even disturbing it to any great extent.

7. The accused brake caliper is cast in two parts, i.e., one part is U-shaped and contains two cylinders; the other part is I-shaped and tops the open end of the U. The I-shaped piece is affixed to a stationary part of the vehicle.

8. In order to obtain access to pistons and friction members in the accused brake, it is necessary, at the very least, to remove the U-shaped portion of the caliper, or roughly

two-thirds of the caliper itself. Other manipulations are also required.

9. The accused brake does not include the teachings of the '870 patent regarding removal of cylinders, pistons and friction members.

Conclusion of Law Regarding Infringement of '870 Reissue Patent

The accused brake does not infringe upon the teachings of the '870 reissue patent.

Discussion Regarding Non-Infringement of '870 Reissue Patent

The defendant asserts as defenses against the claimed infringement the absence in the accused brake of three major features of the '870 patent, i.e., the absence of detachably mounted cylinders, the absence of a thrust element abutting the friction pad centrally and the absence of a means of connecting the thrust element to the friction element for universal pivoting thrust contact.

As is indicated by the Findings of Fact, it is abundantly clear that there are no detachably mounted cylinders in the accused brake. The '870 patent speaks of guide means in the limbs of the caliper, and a pair of coaxial cylinders for each pair of said guide means. The claim item continues, ". . . a pair of coaxial cylinders for each paid of said guide means . . . one cylinder of each pair being detachably mounted on the outboard side of one of the limbs of the housing . . . ."

However liberally one might interpret and however broadly one might apply that language of the claim, there is no commonality with the accused brake composed of a side which has cast into it a cylinder or bore in which only the piston rides and which is not "detachable" in any sense. As a matter of fact, in the accused brake it is not

necessary to remove the cylinder or any part of the housing to remove the pads. The latter service is accomplished merely by unscrewing spring clips and taking the pads out of the opening in the housing. Further, to remove the pistons it is necessary to remove two-thirds of the housing.

With regard to the absence or presence of a thrust element, the '870 patent contemplates the use of what is called a "distance piece," that is, a separate member which is placed in the guide between the piston and the backing plate of the friction member. The argument of applicability to the accused brake by plaintiff seems strange and strained. Strange when one considers that hydraulic pressure means usually contemplate the use of pistons and strained in the attempt to correlate an alleged advantage by the utilization of a separate distance piece to the function of a piston. The plaintiff asserts that the thrust element or distance piece has two major functions, i.e., it dissipates more effectively heat that would normally affect the whole piston and provides a universal pivoting action. Since the accused brake piston is of a piece, the heat dissipation advantage is minimized, if not completely subverted. The tortuous reasoning continues along the line that the front portion of the piston, apparently anywhere from the base forward, is the equivalent of a distance piece or thrust element and that if the piston were cut in two, the result would be a "distance piece."

Following that path can only lead to the inappropriate conclusion that any disc brake which utilizes the piston infringes on the '870 patent, since by its very nature, every piston is used as a pressure or thrust element. Clearly the use of a piston system in disc brakes was long accepted and commonly adapted, as is seen in most if not all of prior art on disc brakes submitted in this case. Additionally, the gratuitous suggestion that infringement occurs because the piston could be cut in two to create two pieces is rebutted by the testimony of defendant's technical ex-

pert that such a structure would be inoperative. Oddly, the remaining portion of the piston, according to plaintiff's definition, would still contain a thrust element in its forward portion.

The universal pivoting connection has been discussed to some extent under the issue of the validity of the '870 patent and much of that discussion is applicable here. Some reference should be made, however, to the demonstrations of the principle of universal pivoting action conducted by plaintiff's patent expert and defendant's technical expert, particularly since it illustrates what is obviously this Court's preferred reliance on defendant's experts throughout this case. Whatever theoretical principle of physics formed the basis of plaintiff's patent expert's demonstration and drawings on this subject, the application to the contested issue and to the actual operation as testified to by defendant's technical expert was not convincing. At the risk of seeming myopic or phobic, the Court cannot envision a "universal pivoting" relationship being created by the flat surface of the backing plate abutting the ends of the piston used by the defendant's accused brake. The conclusion reasonably reached is that when pressured against the disc by the piston, the friction pad is not going to pivot or tilt, but rather is going to compress and wear unevenly depending on the variation in the disc. The theory is sustained by testimony of actual operation and experience.

The '650 Patent

The '650 patent is a fixed caliper, opposing piston, disc brake for railroad cars and heavy industrial equipment. Its structural design and configurations differ from the disc brakes adapted to automobile use. The significant and disputed, feature of the '650 patent as it applies to the brakes in issue is the incorporated feature of the removability of the friction pads.

The specific claim at issue here is Claim 13 which was added to the patent application of the '650 patent on October 28, 1959, some five years after the filing of the original application.

The principle of the '650 patent is contained in the construction of the caliper in such a way that a portion of the caliper itself can be removed to allow the friction members to be replaced without the necessity of removing or disturbing any other part or parts of the brake assembly.

Validity of the '650 Patent

The defendant attacks the validity of Claim 13 of the '650 patent on the following grounds: the claim is not supported by the disclosure of the patent; there was prior art against the claim; the invention was obvious; and the claim language is vague and indefinite. The plaintiff denies the applicability of any of those grounds to Claim 13 and asserts its validity.

Parenthetically, it becomes obvious with even minimal association with disc brakes that after, if not during, the perfection of the disc brake concept, the removability of the friction pads is of paramount importance. By virtue of their nature and use, friction pads wear more quickly than any other brake component and a premium would inevitably be placed on a design and structure which provided a quick, easy and inexpensive method removing and replacing worn friction pads.

1. Claim 13 of the '650 patent reads as follows:

> "A disc brake comprising a rotatable disc; a pair of friction elements, one on each side of said disc and covering only a portion of the braking surfaces of said disc, each of said elements having end portions transverse to the direction of movement of the disc and providing bearing surfaces on which said elements are slidably supported; a stationary torque-resisting mem-

ber having at least three components holding said friction elements from movement in a plane parallel to said disc, and at least one of said components being displacable to permit removal of said friction elements in a plane parallel to said disc and a pair of said components being held in axially spaced positions on each side of and closely spaced from said disc and having surfaces transverse to the direction of rotation of said disc and placed complementarily to the transverse end portions of said friction elements to guide said elements at their opposite ends in movement to and from said disc and to restrain said elements from circumferential movement parallel with said disc; and means to move said friction elements toward said disc, each of said friction elements being between said means and said disc."

2. The design and configuration of the preferred form of the '650 patent describes a fixed caliper brake with the friction pads outside the cylinders.

3. The caliper is shaped, roughly like a rectangular box with the two sides carrying the pistons and, importantly, the two ends slanting inwardly toward the bottom.

4. The ends act as torque-taking and guiding members. Outward or radial movement is prohibited by the top of the housing.

5. In addition to providing these torque-taking and guiding surfaces, the '650 patent teaches the removal of one end of the box-like structure, thus permitting the friction members to be removed circumferentially in a plant parallel to the disc.

6. The removable end piece is a tooth-like member (more dramatically, a bicuspid) which straddles the disc in two planes and is attached to the top of the caliper by a bolting device. Thus, the bolt is unscrewed, the end piece is removed and the friction pads slide out.

7. The other end of the box-like caliper provides a bolting device which permits attachment to a stationary part of the road car or wheel assembly, and also includes a pair of tooth-like members which straddle the disc.

8. Integral to the technical problem of removal and replacement of friction members is the shape and configuration of the caliper, with the additional qualification that it is obviously prudent to avoid a method which requires removal of the sides of the caliper since, generally, they contain the pistons and power units.

9. As has been noted, the essence of the '650 patent is the division of the caliper into three components which provide guiding and anchoring surfaces to the friction pads with one of said components (the "bridge piece," described earlier as the "tooth-like" member) being readily displacable for easy access to the friction pads.

10. With the slanting of the two sets of tooth-like members, the friction pads are prevented from falling inwardly towards the axle of the wheel assembly, and, at the same time, guide the pads towards the disc and also prevent circumferential movement in response to the torque created by the revolving disc.

11. The other component (the bifurcated arms of the base piece), also guides the friction pads from above, so as to speak, and prevents the friction pads from moving radially upward.

12. The pair of said components comprised of the two tooth-like members at opposite ends of the caliper are axially spaced and in close relationship to the disc, that is to say, each pair includes two extensions which straddle the disc, and each of the extensions (a total, thusly, of four) has surfaces transverse to the direction of rotation of the disc and complementary to the transverse end portions of the friction elements.

13. One of the essential elements of a practicable disc brake assembly is a caliper or housing which provides a torque-taking surface. The friction pad removal problem is not necessarily related to the torque-taking function of the caliper, that is, one method may provide for removal by displacement of a torque-taking member while another method may provide for removal without displacement of such a member.

14. The '650 patent method includes the displacement of an end piece which also serves a torque-taking function in the circumferential direction, the major torque action created by the rotation of the disc.

Conclusion of Law Regarding Validity of '650 Patent

Claim 13 of the '650 patent is valid.

Discussion of Validity of '650 Patent

The dispute regarding the '650 patent centered, primarily, on the language of the claim which reads as follows: (Emphasis supplied).

> ". . . a stationary torque-resisting member having at least three *components* holding said friction elements from movement in a plane parallel to said disc, and at least *one of said components being displaceable* to permit removal of said friction elements in a plane parallel to said disc and a *pair of said components being held in axially spaced positions* on each side of and closely spaced from said disc and having surfaces transverse to the direction of rotations of said disc and placed complementarily to the transverse end portions of said friction elements to guide said elements at their opposite ends in movement to and from said disc and to restrain said elements from circumferential movement parallel with said disc; . . ."

Difficulty arises in the definition and identification of the word "components" and the subsequent combinations of

components into "pairs." In the file wrapper, the three components are identified as the displaceable bridge piece at one end of the caliper, the legs of the other end of the caliper and the arms of the bore piece or caliper which are outside of the periphery of the disc (the top of the box, so to speak). This identification is accepted by plaintiff and its experts throughout.

The defendant contends that once having identified the components, the plaintiff cannot subsequently change or alter the components or combine them or portions of them to produce another component. Thus, it is asserted *no pair* of the identical components are "axially spaced" resulting in the failure of the patent to read on itself or, alternatively, then the language is so vague and indefinite as to invalidate the patent.

The plaintiff's response to this attack is the contention that the pair of axially spaced components consist of the two legs of the displaceable component (one leg on each side of the disc) and the two legs of the opposite end of the caliper (also one leg on each side of the disc). In brief, that a portion of one of the identified components (the two legs) and a portion of another component (two legs) comprise a pair of axially spaced components.

At the very least, the language is so imprecise that it requires more than mere perusal of the claim itself and requires an analysis of the specifications and the exemplification of the preferred form.

Firstly, it is to be noted that the claim itself gives some assistance in comprehending the problem when it describes the pair of axially spaced components as having surfaces transverse to the direction of rotation of the disc so as to guide the friction elements and so as to restrain them from circumferential movement. Going then to the specifications and the preferred form, the only members that could provide such surfaces and perform those functions would be

the leg portions of the two ends of the caliper, one a displaceable end.

Bearing in mind the presumption of the validity of a patent, it is apparent that the claim language, with recourse to the specifications and the preferred form, can be found to describe and disclose adequately the patented invention. With the one, however, that in order to avoid the fatal criticism of the defendant's position, the result is the restriction of the language of the claim to the parameters of the disclosure.

This restriction is not a subtle implication imposed indiscriminately, for the Patent Office itself was faced with a limitation of the scope of this patentable feature when it considered and rejected Claim 20. Claim 20 included the following language in lieu of "components" or "pair of components."

> ". . . and an *element* to hold said friction elements from movement in a plane parallel to said disc, and detachably secured to the housing to permit said friction elements to be removed from said housing in a plane parallel to the plane of said disc."

The logical inference is that the rejection of a displaceable "element" was based on the overbroad scope of the term, the failure to conform to the previous disclosures of the patent and the similarity of prior art.

It appears to this Court that the essence of the invention is the provision for a displaceable member which is a working portion of the caliper and is integral to the torque-taking function, but allows the removal of an end piece which does not disturb the power sides of the unit. [To attempt, therefore, to obtain a patent which would cover all pad removal methods, particularly in view of prior art, would not only extend the scope of the disclosures, but would also result in the patenting of a principle.]

Unfortunately, recourse to a dictionary is not helpful in this area since the definition of "component" as a "constituent part of" connotes severability or separate members forming a whole and "elements" as a "part of a whole" connotes "irreducible simplicity" or unseverability. (See Webster's 7th New Collegiate Dictionary.)

Another aspect of the essence of the invention is apparent from the language of the claim. It will be remembered that the claim language provides for a stationary *torque-resisting member having at least three components* and that later in the claim the pair of axially spaced components are described as having transverse surfaces to restrain the friction elements from circumferential movement, to take torque in other words. This serves to strengthen the conclusion that the essence of the invention is as previously set forth, that, simply put, the inventor had devised an end portion of the torque-taking housing.

Considering, then, the analysis above with the innate limitations of the scope of the claim, it appears to the Court, that the prior art does not affect the validity of the patent, that the original disclosure would permit the addition of Claim 13 and that language of the claim is subject to fatal attack neither as to failure to disclose nor as to vagueness or indefiniteness.

The defendant has vigorously contended that the '650 patent is invalid under the "late claiming" doctrine enunciated in *Muncie Geor Works, Inc.* v. *Outboard Marine & Mfg. Co.*, 315 U.S. 759 (1942). In a subsequent consideration of the *Muncie Gear* decision by the Court of Appeals for the Sixth Circuit, then Circuit Judge Potter Stewart stated the essense of the "late claiming" doctrine in *Coats Loaders & Stackers, Inc.* v. *Henderson*, 233 F. 2d 915, 923 (6th Cir., 1956):

> "The ultimate question is: was the invention which is now claimed disclosed in the original application, or was it not disclosed until the amendment . . .'?"

Given the restrictive reading which is necessary to sustain the validity of the '650 patent, the Court finds the necessary disclosure in the original application.

Infringement of '650 Patent

1. The accused brake method includes the displacement of two spring clips on top of the housing but not integral to the housing, which spring clips serve a torque-taking function in a radially outward direction, a minor, if not minimal, torque action created by the rotation of the disc.

2. The accused brake uses the ends of the caliper as guiding and torque-taking surfaces similar generally to the use of the ends of the '650 caliper.

3. The friction members of the accused brake have backing plates which are elongated and which have, on the top ends, ears which fit into and ride on ledges formed into the ends or bridge pieces of the caliper. The ears are held down by the spring clips which are attached to the caliper ends by screws.

4. The accused brake is entirely open on the top and the friction pads may be removed by unscrewing the spring clips from the caliper. The pads are thus removed radially and outwardly in a plane parallel to the disc.

Conclusion of Law Regarding Infringement of '650 Patent

The accused brake does not infringe upon the '650 patent.

Discussion Regarding Infringement of '650 Patent

In attempting to meet its burden on the infringement issue of the '650 patent, it was necessary for plaintiff to attempt comparison of two wholly different structures. The discussion regarding validity of the '650 patent is inextricably bound to the discussion of infringement since the understanding of the scope of the '650 patent is indispensable to the attempted application of its teachings to the accused brake.

An indication of the difficulty of the inartful use of the word "components" appears in the difference between the response of plaintiff to an interrogatory and the preference of its expert witness in identifying the comparable components of the accused brake. In the answer to interrogatory 56, plaintiff identified three components of the accused brake, i.e., 1) the two spring clips, 2) the two ledges, and 3) the combination of the four shoulders on one *side* of the caliper and the four shoulders on the opposite *side* of the caliper. Plaintiff's expert described four components, i.e., 1) the two spring clips, 2) the ledges, 3) the four shoulders on one *end* of the caliper, and 4) the four shoulders on the other *end* of the caliper.

Under either approach, of course, it would be necessary to combine portions of the identified components in order to conclude with a new pair of components which are axially spaced on each side of the disc.

However, the major distinctions between the two devices are obscured by the use of the inconstant word "component." As has been emphasized, the caliper in this type of brake is the torque-taking element and, certainly, is recognized as such in both the patent and the accused brake. There is nothing novel or patentable in that respect in the '650 patent. The '650 patent does teach the displacement of a portion of that torque-taking caliper for removal of the friction pad. The claim of infringement does not go to the similarities of the torque-taking methods, but to the removal process.

Distinctive contrasts that reach compelling proportions are created in the two devices, for example, in the members that are displaced to effectuate removal, the function of those members, the accessability of the pads and the place and direction of the removal. Most importantly, in the '650 patent the removal requires the displacement of an integral end of the caliper, the predominant torque-taking device, whereas in the accused brake, removal requires the dis-

placement of two spring clips which serve little torque-taking function. The clips are attached to, but not integral to the top of the caliper.

Granted this determination of non-infringement depends heavily on the propriety of the determinations made with regard to the validity issue, but again confirmation is found in the attitude of the Patent Office illustrated by its rejection of Claim 20; for Claim 20, which called for a displaceable "element" would have prompted a contrary result.

The '809 Patent

Further development of the disc brake concept eventually resulted in another form which is commonly referred to as to the "sliding" or "floating" caliper disc brake. The fixed caliper brake (the type involved in the prior three patents in suit) consists of pistons and friction pads on each side of the disc and an inert or stationary caliper. The hydraulic pressure is exerted in both sides of the caliper, forcing the opposing pistons against the pads which pinch the disc. The caliper itself is affixed to a stationary member of the wheel assembly.

The sliding caliper brake has a piston on one side only of the caliper and hydraulic pressure is exerted on one side only, forcing the piston against one friction pad and that pad against one side of the disc. The action of the extension of the piston causes a "re-action" which forces the entire caliper to slide and brings the opposing friction pad into contact with the opposite side of the disc to create the pinching effect. Thus, the caliper itself is not stationary but must slide on an additional member which in turn is affixed to a stationary portion of the wheel assembly.

The '809 patent concerns special anchoring and locating members which permit the sliding movement of the caliper: with the assurance of proper brake application.

The preferred form of the '809 patent begins with a substantially flat member in the form of a horseshoe. The

closed end of the shoe is affixed to a non-rotating part of the wheel assembly and provides the support and ultimate torque-taking service. Each of the extended ends of the horseshoe has holes or bosses through which is inserted a pin. The caliper is also U-shaped and rides in a plane perpendicular to and within the exposed area of the support member. It is constructed so that the piston side of the caliper has ears with corresponding holes that slide onto and ride on the pins aforedescribed. The friction elements are constructed so that the metal backing plate members have ears with corresponding holes that also slide onto and ride on the pins. The outer ends of the pins are secured by a metal member, which is a separate piece and improves the rigidity of the structure.

As to the '809 patent, the defendant again claims that there is no infringement and asserts the invalidity of the patent because of prior art not considered by the Patent Office.

Infringement of '809 Patent

The major area of dispute under the infringement issue is represented by Claim 5 of the patent, which reads as follows:

> "In a disc brake including a rotatable disc, the structure comprising a nonrotatable supporting framework comprising a substantially flat support member having two radially extending outwardly projecting limbs forming a notch therebetween disposed alongside said brake disc adjacent one of the radially extending side faces thereof, a pair of combination axially fixed anchoring-and-locating members one on each of said limbs which are angularly spaced apart and extending axially to provide torque taking surfaces located along one side only of said disc and disposed closely adjacent thereto, a pair of friction elements having means providing slidable support relatively to said anchoring-and-locating members disposed one on each side of

said disc to be engageable with opposite braking surfaces of said disc, one of said friction elements consisting of an elongated friction liner and backing having slidable torque-taking remote ends adapted to operatively transmit anchoring thrust to said support member through angularly spaced complementary locations disposed closely adjacent said disc and located adjacent said pair or combination anchoring-and-locating members, a rigid caliper carried by said anchoring-and-locating members and proportioned to be positioned between the said anchoring-and-locating members and having surfaces adapted to be complementary with said torque-taking surfaces and slidably supported thereby at one side of said rotatable disc, said caliper having a pair of limbs straddling the said periphery of the disc, a brake applying mechanism supported by one limb of said caliper and arranged to be operated to press the friction element associated therewith toward the disc and the other limb disposed in operative engagement with the other friction element to move it toward the disc under the reaction set up on the caliper by said brake applying mechanism as said other limb is drawn toward said anchoring-and-locating members, said other friction element being disposed between said other limb and the associated side of said disc, said caliper being freely movable in an axial direction relative to said anchoring-and-locating members and positively located radially and circumferentially with respect to said friction elements."

1. In the preferred form of the '809 patent, the initial torque is taken by the friction member adjacent to the piston-side of the caliper and transmitted through the ears of the backing plate to the pins. Almost simultaneously the opposing friction member contacts the opposite side of the disc and the torque received is transmitted to the pins

through its backing plate ears. Because of the connection obtained by its contact with this friction member, the caliper itself transmits the torque it receives through its ears on the piston-side to the same pins.

2. The torque obtained by the pins is then transmitted to the inner surfaces of the bosses or holes of the flat, stationary torque member.

3. In the accused brake, a horseshoe-shaped member is provided which is affixed to a stationery member of the wheel assembly.

4. Each of the two open ends of the horseshoe have bosses or holes and are also notched.

5. The caliper of the accused brake has corresponding holes. Pins are inserted through the caliper holes and the torque plate ends to provide the sliding surface. As a part of this assembly, flex straps are also provided, one end of each is affixed to the torque plate and the other end is connected to the pin.

6. Neither of the friction members has any connection or contact with the pins, nor do the pins extend beyond the periphery of the disc.

7. The piston side of the caliper is machined so as to provide areas which fit into the notches of the open ends of the torque plate and abut the surface of those notches.

8. The piston-side friction member includes a backing plate which is guided in and by raised portions or shoulders or the torque plate. This backing plate has hook-like extension or ears which are supported by and ride on these raised portions of the torque and are also inhibited by spring clips.

9. The opposing friction member is affixed to the opposite extensions of the caliper by screws or bolts and notches.

10. The initial torque is taken by the piston-side friction member via its backing plate and transmitted directly to the torque plate. Almost simultaneously the opposing friction member makes contact with the disc and that torque is transmitted to the caliper. This latter torque travels through the caliper, so to speak, and is transmitted from the caliper to the torque plate at the notching connections.

11. Because of the notching connection between the torque plate and the caliper, the pins supplying the sliding surface have no or minimal torque-taking or transmitting function.

12. Defendant's accused sliding caliper brake does not have "a pair of combination axially fixed anchoring-and-locating members one on each of said members which are angularly spaced apart and extending axially to provide torque-taking surface-located along one side only of said disc and disposed close adjacent thereto" as called for in Claims 5-8 of the '809 patent. In defendant's accused brakes the anchoring and the locating or guiding functions are performed by separate and different structures. The anchoring is done by shoulders which engage surfaces on the caliper to anchor the caliper against rotative movement and to take the torque. The locating or guiding function is performed by pins which slide in the torque plate and are not axially fixed and do not take torque and by metal flex straps which flex axially and do not take torque.

13. In defendant's accused sliding caliper brake the caliper is not "carried by said anchoring-and-locating members" as called for in Claims 5-8 of the '809 patent, but is carried by the pins and flex straps which are not "combination anchoring-and-locating members."

14. In defendant's accused sliding caliper brakes there are no "means providing slidable support" for both friction elements as called for in Claims 5-8 of the '809 patent because one of the friction elements is fixedly mounted in

the caliper and does not slide on any supporting structure such as pins as used in the '809 patent brake.

15. In defendant's accused sliding caliper brakes the caliper is not "freely movable in an axial direction relative to said anchoring-and-locating members" as called for in Claims 5-9 of the '809 patent because defendant's caliper is located and guided by pins and metal flex straps fixed to it which are movable relative to the torque plate and the caliper cannot move until it overcomes the resistance to movement offered by the flex straps and the rubber grommets which surround the pins.

16. Defendant's accused sliding caliper brakes do not use substantially the same structure to accomplish substantially the same results in substantially the same way as the '809 patent brake.

17. All of the mechanical elements called for in Claims 5-8 of the '809 patent are not present in defendant's accused sliding caliper brake.

Conclusion of Law Regarding Infringement of '809 Patent

The accused sliding caliper brakes do not infringe Claims 5-8 of the '809 patent.

Discussion Regarding Non-Infringementof '809 Patent

The specificity of the Findings of Fact relating to the '809 patent infringement do not require extensive discussion. The most liberal interpretation of the '809 patent does not serve to bring the accused brake within the ambit of the claim language.

The '809 patent, as is evident from the testimony and prior are references, does not purpose to be the mother invention of the sliding caliper brake concept, nor the first to use pins as the mode of the sliding surface. The improvements asserted on behalf of the '809 patent do not find response in the accused brake. The original taking of

the torque and the transmittal methods, for example, are entirely different and, in fact, the accused brake compares more proximately to the Chouings brake in those particulars than the '809 patent. Thus, the infringement issues should be read in light of the findings and discussion of the validity issues following.

Again, it is to be noted that the Court was more impressed with the testimony of defendant's experts and the pragmatic reasonableness of their approach and explanation.

Validity of '809 Patent

The defendant claims that the '809 patent is invalid and bases its attack on the prior art illustrated by British Patent No. 717,350 (the Chouings Patent), U.S. Patent No. 3,081,841 (the Dotto Patent), U.S. Patent No. 3,260,332 (the Wells Patent), an article in the October 8, 1952, issue of "The Motor Magazine" and several other U.S. patents, none of which were considered by the U.S. Patent Office prior to the issuance of the '809 patent.

1. In the Chouings Patent preferred form there is described a substantially flat, horseshoe-shaped torque plate which is affixed to a stationary part of the wheel assembly; the torque plate open ends are provided with holes or bosses and notches; the U-shaped caliper has corresponding holes on each side of its limbs which permit the entry of pins through the holes in the caliper and the bosses of the torque plate; the piston side friction member is guided and supported in the notches of the torque plate; the opposite friction member is attached to the opposite side of the caliper by means of notches and bolts; there is no connection between the respective friction members and the pins; the caliper, however, is slidably supported and guided by the pins.

2. In the Chouings Patent, the piston side friction member accepts torque and transmits it directly to the torque

plate; the opposite friction member, being affixed to and riding within the confines of the caliper, transmits the torque directly to the caliper, which in turn, transmits to the pins and through them to the torque plate.

3. The claims of the '809 patent read equally well on the Chouings patent and the accused brake.

4. In the Dotto patent, there is provided a substantially flat torque plate in a general U-shape with one end affixed to a stationary part of the wheel assembly; on the piston side, the torque plate's open ends have two holes in each end; the outer holes are used to connect that torque plate to the extending portions of a metal member on the opposite side of the disc which is also U-shaped but is not otherwise affixed to any stationary part of the wheel assembly; the inner holes correspond to holes in the caliper and pins are used through these holes to provide slidable support for the caliper; the piston side friction member rides in the grooves or notches of the piston side torque plate while the opposite friction member rides in the grooves of the opposite connected or annexed metal member; on the piston side, torque is transmitted directly from the friction member to the torque plate; on the opposite side, torque is transmitted directly to the annexed torque member and is borne by the bolt connection of the combination torque plate; the inner pins allow the caliper to slide, but do not provide any torque taking or transmitting function.

5. The Dotto prior art United States Letters Patent No. 3,081,841 which issued on March 19, 1963, discloses a disc brake structure which is closer in mode of operation and function to the '809 patent in suit than is defendant's accused brake, and if Claim 5 of the '809 patent is interpreted broadly enough to cover the brake disclosed in the '809 patent and to cover defendant's accused sliding caliper brake then all of the mechanical elements called for in Claim 5 of the '809 patent are present in the Dotto prior art brake.

6. The additional prior art offered by the defendant in support of its claim of invalidity, also finds appreciable response in the '809 patent in suit.

Conclusion Regarding Validity of '809 Patent

The '809 patent is invalid under 35 U.S.C. § 102(a), (b), or § 103.

Discussion Regarding Validity of '809 Patent in Suit

Comparisons between the '809 patent, the accused brake, the Chouings patent and the Dotto patent, along with other prior art references, convince this Court that had the Patent Office considered the prior art it could not have found the '809 offering patentable and further, that the accused brake finds more appropriate response to the prior art.

The Chouings prior art, particularly, reads very closely on the accused brake. It is of interest to note that although plaintiff's British and American patent personnel discussed the Chouings patent, it was not brought to the attention of the U.S. Patent Office.

The major distinction drawn by the plaintiff in rebuttal of defendant's contention of the Chouings patent, was the axial extension of the holes or bosses at the open ends of the torque plate. The claimed import of this distinction is that the lack of axial extension permitted a tilting action which resulted in improper friction pad application and wear. Plaintiff further contends that an ex parte test of the Chouings '809 brake and the accused brake indicated the disadvantages of the tilting movement of the Chouings brake.

It is apparent from a reading of the Chouings patent that this tilting movement was looked upon as an advantage by the inventor because it purportedly allowed an adjustment to variations of the disc. The patent describes the holes in the torque plate (or bracket as referred to in

the patent) to be of "only a very short length" to allow the tilting. Thus, the inference can be drawn readily and reasonably that the inventor was particularly concerned with the thickness or "axial extension" of the surface of these holes and specifically opted for "short" holes in order to provide for the tilting action that he saw advantageous. The converse of that seems obvious: the longer the length of the holes, the less tilting. It is a simple step to increase the "axial extension" of the holes or bosses to the point of minimal or no tilting, the result and advantage claimed by the plaintiff '809 patent.

Had the Chouings patent made no reference to the extent of the surface of the holes or bosses, the position of plaintiff would have been more palatable as it relates to the tilting action. The specific emphasis placed on the "very short length" of the surface of the hole so as to provide tilting, however, rebounds against plaintiff's strongly asserted position and dictates the obvious conclusion that different surface extensions will affect tilting action. This can be easily accomplished by providing a thicker torque plate or by thickening in some fashion a portion of the open ends of the torque plate.

The argument of plaintiff that the effect of the "short length" holes is to provide torque-taking "edges" as opposed to torque-taking "surfaces" as exemplified in the '809 patent is hardly significant. The point is that the surface of the holes take the torque; the axial extension of the holes determining the tilt or lack of it.

Plaintiff asserts with regard to the applicability of the Dotto prior act patent that the Dotto construction does not include a "flat" torque plate so as to provide an advantageous air cooling of the friction pads. There has been a general assumption throughout the trial that a major advantage of the disc brake is the open construction which permits the heat to dissipate easily and quickly. The Court readily grasps the contribution to this advantage by virtue of the size of a disc brake and the fact that it contacts and

has relationship to a portion only of the disc. However, the Court was not apprised of the significance in the heat-dissipation area by virtue of different constructions; e.g., does the construction of Dotto in fact or theory significantly reduce the ability to air cool the friction pads as compared to the '809 patent? Granted it is obvious that the more open the construction is, the more the air that can reach the pads, but lacking testimony on the subject, this Court is not prepared nor competent to speculate on the degrees of difference and ultimately the effects on improvement or detriment. Thus, the disadvantage, in Dotto, of having the one side of the combination torque plate covering a portion of the outer periphery of the disc is apparent; however, whether this disadvantage affects the workability and efficiency of the Dotto brake is not evident nor reasonably inferable in this record.

The dispute as to the applicability of Dotto, then, concerns two subjects; i.e., the lack of mechanical or bonding connections between the pad and its backing plate, and the torque-taking elements.

With regard to the connection between pad and backing plate (which may affect the method of torque acceptance and transmittal) this Court finds it difficult to differentiate between a mechanical or bonding connection (e.g. by adhesives) and the connection developed by the application of pressure created by hydraulic or some other activating force. Further, if there is a difference, it appears obvious that a mechanical or bonding connection would hardly be of patentable novelty.

With regard to the torque-taking apparatus, plaintiff contends that while the piston side of the torque plate may be flat in Dotto as called for in the '809 patent the annexation of the straddling member which extends on the opposite side of the disc not only destroys the flatness element but results in torque being taken on the opposite side of the disc and not to and through the pins.

If the flatness element is of such vital significance to the '809 patent, then the Court fails to follow the argument of plaintiff that the torque plate of the accused brake is "substantially flat" and reads on the '809 patent. It is inconsistent to minimize the shoulders or flanges of the torque plate used by defendant which support and guide the friction members and emphasize the configuration of the Dotto combination or annexed torque plate.

The testimony of plaintiff's expert, Fishley, was equivocal as to the torque transmission method and pattern of the Dotto brake. There was uncertainty regarding the torque-taking potential of the annex portion of the torque plate, the role of the pins connecting the two portions and the potential of the "unified" torque plate. Suffice it to say, the pin bolts connecting the Dotto torque plate appear to carry a substantial burden in the torque-taking process and are, thereby, closely akin to the function and contribution of the pins in the '809 patent.

Discussion Regarding Other Claims

The defendant in its counterclaim has also claimed that the patents in suit are unenforceable because of plaintiff's unclean hands, misuse of the patents and violations of antitrust laws and that the violation of antitrust laws entitle defendant to treble damages based on its attorneys' fees and costs.

In view of the Court's decision as to the validity and infringement issues, the enforceability of the patents in suit becomes a moot question.

As to the alleged violation of antitrust laws, the Court does not consider that the defendant has met its burden of proof in that regard.

It is not, of course, uncommon for allegations to be made in lawsuits for the purpose of tainting the conduct and bona fides of one's opponent. In the case at bar, such

innuendos were indulged in by both sides, e.g., the inference that the defendant acquired trade secrets or technical knowledge from plaintiff that permitted it to modify its structures, albeit unsuccessfully, to avoid infringement; the inferences that plaintiff, on the other hand, withheld information regarding Goodyear activity. Such inferences and innuendos, however, did not rise to the standard of proof requisite to establish any equitable doctrines or violation of antitrust statutes.

Therefore, the Court will deny the request of the respective parties for treble damages and awards of other than statutory attorney fees.

Counsel are requested to confer and present an order of judgment in accordance with the foregoing Memorandum Opinion.

PHILIP PRATT
Philip Pratt
United States District Judge

Dated: May 15, 1972.

APPENDIX C

Final Order and Judgment in the District Court

(June 1, 1972)

This case having been tried before the Court without a jury, and evidence having been submitted by both parties and the Court having heard and considered the same and having entered its Memorandum Opinion therein:

IT IS HEREBY ORDERED, ADJUDGED AND DECREED, as follows:

1. Claims 1-4, 7, 11 and 12 of the '516 patent are invalid and not infringed by Defendant.

2. Claim 9 of the '870 patent is invalid and not infringed by Defendant.

3. Claim 13 of the '650 patent is valid but not infringed by Defendant.

4. Claims 5-8 of the '809 patent are invalid and not infringed by Defendant.

5. The Amended Complaint is dismissed with prejudice against Plaintiff.

6. Defendant's Counterclaim is dismissed with prejudice against Defendant.

7. Defendant is entitled to recover its costs in this matter.

/s/ PHILIP PRATT
United States District Judge

Dated: June 1, 1972

APPENDIX D

SUPREME COURT OF THE UNITED STATES

No. A-462

THE DUNLOP COMPANY, LIMITED, Petitioner,

v.

KELSEY-HAYES COMPANY

Order Extending Time to File Petition for Writ of Certiorari

UPON CONSIDERATION of the application of counsel for petitioner(s),

IT IS ORDERED that the time for filing a petition for writ of certiorari in the above-entitled cause be, and the same is hereby, extended to and including December 21, 1973.

/s/ POTTER STEWART
Associate Justice of the Supreme Court of the United States

Dated this Eighth day of November, 1973.

APPENDIX E

§ 571.105 Standard No. 105; Hydraulic service brake, and parking brake systems.

S1. *Purpose and scope.* This standard specifies requirements for hydraulic service brake, emergency brake, and parking brake systems intended to ensure adequate braking performance under normal and emergency conditions.

S2. *Application.* This standard applies to passenger cars.

S3. *Definitions.* "Pressure component" means any internal component of the brake master cylinder or master control unit, wheel brake cylinder, brake line, brake hose, or equivalent, except vacuum assist components.

S4. *Requirements.*

S4.1 *Service brake system.* The performance ability of the fully operational service brake system for passenger cars shall be not less than that described in Section D of Society of Automotive Engineers Recommended Practice J937, "Service Brake System Performance Requirements —Passenger Cars", June 1966, and tested in accordance with SAE Recommended Practice J843a, "Brake System Road Test Code—Passenger Cars", June 1966, except that the following is substituted for section (D)(7)(a) of SAE Recommended Practice J937:

"Brakes to recover within +20%, —40% of check stop pedal force by stop 15 or within +20 lbs., —40% of check stop pedal force by stop 10. (Based on the average of initial pedal force of the three check stops)."

S4.2 *Emergency brake system.* Rupture or leakage-type failure of any single pressure component of the service brake system, except structural failures of the brake master cylinder body or effectiveness indicator body, shall not result in complete loss of function of the vehicle brakes when force on the brake pedal is continued.

S4.2.1 *Emergency System Performance.* If failure of a pressure component or insufficient hydraulic fluid in the system causes loss of pressure in any part of the brake system, the remaining portion of the brake system shall provide a stop of the vehicle loaded in accordance with SAE Recommended Practice J843a, June 1966, from a speed of 60 m.p.h., in not more than 646 feet, without pulling or swerving to the extent that would cause the vehicle to leave a level, 12-foot wide lane on a clean, dry, smooth, portland cement concrete pavement (or other surface with equivalent coefficient of surface friction).

S4.2.2 *Emergency brake system effectiveness indication.* An electrically operated red light, mounted on the instrument panel in view of the driver, shall illuminate before or upon application of the brakes in the event of a hydraulic-type complete failure of a partial system. The indicator light shall have sufficient luminous intensity to be plainly visible in daylight and shall include a means for testing by the vehicle operator to ensure that the bulb is operable. No single failure in the internal components of the system effectiveness indicator, except the body of the device, shall permit the total loss of effectiveness of the braking system.

S4.3 *Parking brake system.* A parking brake system of a friction type with a solely mechanical means to retain engagement shall be provided that will hold the vehicle loaded in accordance with SAE Recommended Practice J843a, June 1966, to the limit of traction of the braked wheels in both forward and reverse directions on clean, dry, smooth, portland cement concrete pavement (or other surface with equivalent coefficient of surface friction) of a 30 percent grade.

NOTE: (1) The definition of the term "emergency brake" contained in § 571.3(b) does not refer to a system that would provide a means of bringing a vehicle to a stop after a total failure of the entire hydraulic service brake system, since paragraph S4.2 of the Standard provides that rupture

or leakage-type failure of any single pressure component of the service brake system, except structural failures of the brake master cylinder body or effectiveness indicator body shall not result in complete loss of function of the vehicle brakes when force on the brake pedal is continued.

(2) Paragraph S4.2.1 applies to loss of pressure in a part of the brake system resulting from failure of a pressure component or insufficient hydraulic fluid in that part of the system.

(3) The requirement of paragraph S4.2.2 that an indicator light illuminate before or upon application of the brakes in the event of a hydraulic-type complete failure of a partial system may be met with a master cylinder reservoir level indicator light or system pressure indicator light. The indicator light need not illuminate during that application of brake pressure that contributed to the failure.

§ 571.105a Motor Vehicle Safety Standard No. 105a; hydraulic brake systems. (Effective Sept. 1, 1974)

S1. *Scope.* This standard specifies requirements for hydraulic service brake and associated parking brake systems.

S2. *Purpose.* The purpose of this standard is to insure safe braking performance under normal and emergency conditions.

S3. *Application.* This standard applies to passenger cars, multipurpose passenger vehicles, trucks, and buses equipped with hydraulic service brake systems.

S4. *Definitions.* "Antilock system" means a portion of a service brake system that automatically controls the degree of rotational wheel slip at one or more road wheels of the vehicle during braking.

"Brake power assist unit" means a device installed in a hydraulic brake system that reduces the operator effort required to actuate the system, and that if inoperative

does not prevent the operator from braking the vehicle by a continud application of muscular force on the service brake control.

"Brake power unit" means a device installed in a brake system that provides the energy required to actuate the brakes, either directly or indirectly through an auxiliary device, with the operator action consisting only of modulating the energy application level.

"Brake proportioning system" means a system that automatically adjusts the braking force at the axles to compensate for vehicle static axle loading and/or dynamic weight transfer between axles during deceleration.

"Hydraulic brake system" means a system that uses hydraulic fluid as a medium for transmitting force from a service brake control to the service brake, and that may incorporate a brake power assist unit, or a brake power unit.

"Initial brake temperature" means the average temperature of the service brakes on the hottest axle of the vehicle 0.2 mile before any brake application.

"Lightly loaded vehicle weight" means:

(a) For vehicles with a GVWR of 10,000 pounds or less, unloaded vehicle weight plus 300 pounds (including driver and instrumentation);

(b) For vehicles with a GVWR greater than 10,000 pounds, unloaded vehicle weight plus 500 pounds (including driver and instrumentation).

"Pressure component" means a brake system component that contains the brake system fluid and controls or senses the fluid pressure.

"Skid number" means the frictional resistance of a pavement measured in accordance with American Society for Testing and Materials Method E-274-65T at 40 m.p.h.,

omitting water delivery as specified in paragraph 7.1 of that method.

"Snub" means the braking deceleration of a vehicle from a higher reference speed to a lower reference speed that is greater than zero.

"Speed attainable in 2 miles" means the speed attainable by accelerating at maximum rate from a standing start for 2 miles on a level surface.

"Spike stop" means a stop resulting from the application of 200 pounds of force on the service brake pedal in 0.08 second.

"Split service brake system" means a brake system consisting of two or more subsystems actuated by a single control designed so that a leakage-type failure of a pressure component in a single subsystem (except structural failure of a housing that is common to all subsystems) shall not impair the operation of any other subsystem.

"Stopping distance" means the distance traveled by a vehicle from the point of application of force to the brake control to the point at which the vehicle reaches a full stop.

S5. *Requirements.*

S5.1 *Service brake system.* Each vehicle shall be manufactured with a split service brake system, and shall be capable of meeting the requirements of S5.1.1 through S5.1.6, under the conditions specified in S6, when tested according to the procedures and in the sequence in S7. If a vehicle is incapable of attaining a speed specified in S5.1.1, S5.1.2, S5.1.3, or S5.1.6 its service brakes shall be capable of stopping the vehicle from the multiple of 5 m.p.h. that is 4 m.p.h. to 8 m.p.h. less than the speed attainable in 2 miles, within distances and with pedal forces that do not exceed the distances and forces specified in Table II. If a vehicle is incapable of attaining a speed specified in S5.1.4

in the time or distance interval set forth, it shall be tested at the highest speed attainable in the time or distance interval specified.

S5.1.1 *Stopping distance.* The service brakes shall be capable of stopping each vehicle in four effectiveness tests within the distances, and from the speeds and with the pedal forces specified below.

S5.1.1.1 In the first (preburnished) effectiveness test, the vehicle shall be capable of stopping from 30 m.p.h. and 60 m.p.h. within the distances and with pedal forces that do not exceed the distances and forces specified in Column I of Table II.

S5.1.1.2 In the second and fourth effectiveness tests, the vehicle shall be capable of stopping from 30 m.p.h., 60 m.p.h., 80 m.p.h., and the multiple of 5 m.p.h. that is 4 m.p.h. to 8 m.p.h. less than the speed attainable in 2 miles if this speed is 95 m.p.h. or greater, within the distances and with pedal forces that do not exceed the distances and forces specified in Column II of Table II.

S5.1.1.3 In the third effectiveness test (lightly loaded vehicle), the vehicle shall be capable of stopping at lightly loaded vehicle weight from 60 m.p.h. within the distances and with pedal forces that do not exceed the distances and forces specified in Column II of Table II.

S5.1.2 *Partial failure.* In the event of a rupture or leakage-type failure in a single subsystem, other than a structural failure of a housing that is common to two or more subsystems, the remaining portion(s) of the service brake system shall continue to operate, and shall be capable of stopping a vehicle from 60 m.p.h. within distances and with pedal forces that do not exceed the distances and forces specified in Column III of Table II.

S5.1.3 *Inoperative brake power assist unit or brake power unit.* The service brakes shall be capable of stopping a vehicle equipped with a brake power assist unit or brake power unit with such unit rendered inoperative, from 60 m.p.h. within distances and with pedal forces that do not exceed the distances and forces specified in Column III of Table II.

S5.1.4 *Fade and recovery.* The service brakes shall be capable of stopping each vehicle in two fade and recovery tests.

S5.1.4.1 The pedal force used for the baseline check stops or snubs shall be not less than 15 pounds, nor more than 60 pounds.

S5.1.4.2 (a) Each vehicle with a GVWR of 10,000 pounds or less shall be capable of making 10 fade stops (15 fade stops on the second test) from 60 m.p.h. at 15 f.p.s.p.s. for each stop with a pedal force that does not exceed 150 pounds for any stop.

(b) Each vehicle with a GVWR greater than 10,000 pounds shall be capable of making 10 fade snubs (20 fade snubs on the second test) from 40 m.p.h. to 20 m.p.h. at 10 f.p.s.p.s. for each snub, with a pedal force that does not exceed 150 pounds for any snub.

S5.1.4.3 (a) Each vehicle with a GVWR of 10,000 pounds or less shall be capable of making five recovery stops from 30 m.p.h. at 10 f.p.s.p.s. for each stop, with a pedal force that does not exceed 150 pounds for any of the first four stops, and that for the fifth recovery stop is within plus 20 pounds and minus 5 pounds or minus 40 percent (whichever is greater) of average pedal force for the baseline check.

(b) Each vehicle with a GVWR greater than 10,000 pounds shall be capable of making 5 recovery snubs from

40 m.p.h. to 20 m.p.h. at 10 f.p.s.p.s. for each snub, with a pedal force that does not exceed 150 pounds for any of the first four snubs, and that for the fifth snub is within plus 20 pounds and minus 5 pounds or minus 40 percent (whichever is greater) of the average pedal force for the baseline check.

S5.1.5 *Water recovery.* The service brakes shall be capable of stopping each vehicle in a water recovery test, within the distances, and from the speeds and with the pedal forces specified below.

S5.1.5.1 The pedal force used for the baseline check stops shall be not less than 15 pounds nor more than 60 pounds.

S5.1.5.2 After being driven for at least 2 minutes at a speed of 5 m.p.h., in any combination of forward and reverse directions, through a trough having a water depth of 6 inches, each vehicle shall be capable of making 5 recovery stops from 30 m.p.h. at 10 f.p.s.p.s. for each stop with a pedal force that does not exceed 150 pounds for any of the first four stops, and that for the fifth recovery stop is within plus 20 pounds and minus 5 pounds or minus 40 percent (whichever is greater) of the average pedal force for the baseline check.

S5.1.6 *Spike stops.* Each vehicle shall be capable of making 10 spike stops from 30 m.p.h., followed by six effectiveness (check) stops from 60 m.p.h., at least one of which shall be within a stopping distance and with a pedal force that does not exceed the distances and forces specified in column II of table II.

S5.2 *Parking brake system.* Each vehicle shall be manufactured with a parking brake system of a friction type with a solely mechanical means to retain engagement, which shall under the conditions of S6, when tested according to the procedures specified in S7, meet the requirements specified in S5.2.1, S5.2.2, or S5.2.3, as applicable, when the system is engaged with a force applied to the control not

to exceed 125 pounds for a foot-operated system and 90 pounds for a hand-operated system.

S.5.2.1 Except as provided in S5.2.2, the parking brake system on each passenger car, and on each multipurpose passenger vehicle, truck or bus, with a GVWR of 10,000 pounds or less, shall be capable of holding the vehicle stationary for 5 minutes, in both a forward and reverse direction, on a 30 percent grade.

S5.2.2 A vehicle of a type described in S5.2.2.1 at the option of the manufacturer may meet the requirements of S5.2.2.1, S5.2.2.2, and S5.2.2.3 instead of the requirements of S5.2.1 if:

(a) The vehicle has a transmission or transmission control which incorporates a parking mechanism (hereafter referred to as the "mechanism"); and

(b) The mechanism must be engaged before the ignition key can be removed.

S5.2.2.1 The vehicle's parking brake and the mechanism, when both are engaged, shall be capable of holding the vehicle stationary for 5 minutes, in both the forward and reverse directions, on a 30 percent grade.

S5.2.2.2 The vehicle's parking brake, with the mechanism not engaged, shall be capable of holding the vehicle stationary for 5 minutes, in both the forward and reverse directions, on a 20 percent grade.

S5.2.2.3 With the mechanism engaged and the parking brake not engaged the mechanism shall not disengage or fracture in a manner permitting vehicle movement, when the vehicle is impacted at each end, on a level surface, by a barrier moving at 2½ m.p.h.

S5.2.3 The parking brake system on each multipurpose passenger vehicle, truck, or bus, with a GVWR greater than 10,000 pounds, shall be capable of holding the vehicle sta-

tionary for 5 minutes, in both the forward and reverse directions, on a 20 percent grade.

S5.3 *Brake system indicator lamp.* Each vehicle shall have one or more brake system indicator lamps mounted in front of and in clear view of the driver, which meet the requirements of S5.3.1 through S5.3.4.

S5.3.1 An indicator lamp shall be activated when the ignition switch is in the "on" position and whenever any of the following conditions occur:

(a) A pressure failure in any part of the service brake system, other than a structural failure of a housing that is common to two or more subsystems, before or upon application of 50 pounds of pedal force upon a fully manual service brake or of 25 pounds of pedal force upon a service brake with a brakepower assist unit, or when the supply pressure in a brake power unit drops to not less than one-half of the normal system pressure.

(b) A drop in the level of brake fluid in a master cylinder reservoir to less than the recommended safe level specified by the manufacturer, or to not less than one-fourth the fluid reservoir capacity in any reservoir compartment, whichever is greater.

(c) A total electrical failure in an antilock or brake proportioning system.

(d) Application of the parking brake.

S5.3.2 All indicator lamps shall be activated when the ignition switch is turned from the "on" or "run" position to the "start" position.

S5.3.3 Except for the momentary activation required by S5.3.2, each indicator lamp, once activated, shall remain activated as long as the condition exists, whenever the ignition switch is in the "on" position. An indicator lamp activated when the ignition switch is turned to the "start"

position shall be deactivated upon return of the switch to the "on" or "run" position or when the parking brake is released, unless a failure of the kind described in S5.3.1(a) to S5.3.1(c) exists in the service brake system.

S5.3.4 Each indicator lamp shall have a lens labeled "Brake" in letters not less than one-eighth inch high, which shall be legible to the driver in daylight when lighted. The lens and the letters shall have contrasting colors, one of which is red. An antilock system may have a separate lens labelel "Antilock," in letters not less than one-eighth inch high, which shall be legible to the driver in daylight when lighted, if the indicator is used only for the antilock system. The lens and the letters shall have contrasting colors, one of which is yellow.

S5.4 *Reservoirs.*

S5.4.1 *Master cylinder reservoirs.* A master cylinder shall have a reservoir compartment for each service brake subsystem serviced by the master cylinder. Loss of fluid from one compartment shall not result in a complete loss of brake fluid from another compartment.

S5.4.2 *Capacity.* Each reservoir compartment shall have a minimum capacity equivalent to the fluid displacement resulting when all the wheel cylinders or caliper pistons serviced by the reservoir move from a new lining, fully retracted position (as adjusted initially to the manufacturer's recommended setting) to a fully worn, fully applied position. Each brake power unit reservoir servicing only the brake system shall have a minimum capacity equivalent to the fluid displacement required to charge the system piston(s) or accumulator(s) to normal operating pressure plus the displacement resulting when all the wheel cylinders or caliper pistons serviced by the reservoir or accumulator(s) move from a new lining fully retracted position (as adjusted initially to the manufacturer's recommended setting) to a fully worn, fully applied position.

S5.4.3 *Reservoir label.* Each vehicle shall have the following label appropriately completed with the manufacturer's recommendation as to the type of fluid, as specified in Standard No. 116 (49 CFR 571.116), to be used in the vehicle brake system. The label shall be located so as to be visible by direct view, permanently affixed, stamped, or embossed either on or within 4 inches of the brake fluid reservoir filler plug or cap, in lettering at least one-eighth of an inch high on a contrasting background:

WARNING

Use only ..... fluid
from a sealed container.

Clean filler cap before removing.

S5.5 *Antilock and brake proportioning systems.* In the event of failure (structural or functional) in an antilock or brake proportioning system the vehicle shall be capable of meeting the stopping distance requirements specified in S5.1.2 for service brake system partial failure.

S5.6 *Brake system integrity.* Each vehicle shall be capable of completing all performance requirements of S5 without:

(a) Detachment or fracture of any component of the braking system, such as brake springs and brake shoe or disc pad facing, other than minor cracks that do not impair attachment of the friction facing. All mechanical components of the braking system shall be intact and functional. Friction facing tearout (detachment) shall not exceed 10 percent of the lining surface area on any single frictional element.

(b) Any visible brake fluid or lubricant on the friction surface of the brake, or at the master cylinder or brake power unit reservoir cover, seal and filler openings.

S6. *Test conditions.* The performance requirements of S5 shall be met under the following conditions. Where a

range of conditions is specified, the vehicle shall be capable of meeting the requirements at all points within the range.

S6.1 *Vehicle weight.*

S6.1.1 Except for tests specified in S7.6.3, S7.7, and S7.8.1, the vehicle is loaded to its gross vehicle weight rating, distributed proportionally to its gross axle weight rating, except that the fuel tank is filled to any level from 100 percent of capacity (corresponding to full GVWR loading) to 75 percent of capacity.

S6.1.2 For the tests specified in S7.6.3, S7.7, and S7.8.1, vehicle weight is lightly loaded vehicle weight, with the added weight distributed in the front passenger seat area in passenger cars, multipurpose passenger vehicles and trucks, and in the area adjacent to the driver's seat in buses.

S6.2 *Tire inflation pressure.* Tire inflation pressure is the pressure recommended by the vehicle manufacturer for the GVWR of the vehicle.

S6.3 *Transmission selector control.* For S7.3, S7.5, S7.7, S7.14, S7.16, S7.10.1.2, S7.10.2.2, S7.10.3.2, and as required for S7.12, the transmission selector control is in neutral for all decelerations. For all other tests during all decelerations, the transmission selector control is in the control position, other than overdrive, recommended by the manufacturer for driving on a level surface at the applicable test speed. To avoid engine stall in vehicles equipped with a manual transmission, the transmission may be shifted to neutral (or the clutch disengaged) when the vehicle speed decreases to 20 m.p.h.

S6.4 *Engine.* Engine idle speed and ignition timing settings are according to the manufacturer's recommendations. If the vehicle is equipped with an adjustable engine speed governor, it is adjusted according to the manufacturer's recommendation.

S6.5 *Vehicle openings.* All vehicle openings (doors, windows, hood, trunk, convertible top, cargo doors, etc.) are closed except as required for instrumentation purposes.

S6.6 *Ambient temperature.* The ambient temperature is any temperature between 32° F. and 100° F.

S6.7 *Wind velocity.* The wind velocity is zero.

S6.8 *Road surface.* Road tests are conducted on a 12-foot-wide, level roadway having a skid number of 75. Burnish stops are conducted on any surface. The parking brake test surface is clean, dry, smooth portland cement concrete.

S6.9 *Vehicle position.* The vehicle is aligned in the center of the roadway at the start of each brake application. Stops, other than spike stops, are made without any part of the vehicle leaving the roadway. Stops are made without lockup of any wheel at speeds greater than 10 m.p.h., except that there may be (a) controlled lockup on an antilock-equipped axle, and (b) lockup of not more than one wheel uncontrolled by an antilock system.

S6.10 *Thermocouples.* The brake temperature is measured by plug-type themocouples installed in the approximate center of the facing length and width of the most heavily loaded shoe or disc pad, one per brake, as shown in Figure 1. For center-grooved shoes or pads, thermocouples are installed within one-eighth to one-quarter inch of the groove and as close to the center as possible.

S6.11 *Initial brake temperature.* Unless otherwise specified the initial brake temperature is 150° F. to 200° F.

S6.12 *Test loads.* The load is distributed on the load carrying platform, and the load material density is any value from 50 to 725 pounds per cubic foot.

S7. *Test procedures and sequence.* Each vehicle shall be capable of meeting all the requirements of S5 when tested

according to the procedures and in the sequence set forth below, without replacing any brake system part or making any adjustments to the brake system other than as permitted in S7.4, S7.8, and S7.9. A vehicle shall be deemed to comply with S5.1 if at least one of the stops at each speed and load specified in each of S7.3, S7.5, S7.7, S7.8, S7.9, S7.14, or S7.16 is made within a stopping distance and with a pedal force that does not exceed the limits specified in Table II.

S7.1 *Brake warning.* If the initial brake temperature for the first stop in a test procedure (other than S7.6 and S7.15) has not been reached, heat the brakes to the initial brake temperature by making not more than 10 snubs from not more than 40 m.p.h. to 10 m.p.h, at a deceleration not greater than 10 f.p.s.p.s.

S7.2 *Pretest instrumentation check.* Conduct a general check of instrumentation by making not more than 10 stops from a speed of not more than 30 m.p.h., or 10 snubs from a speed not more than 40 m.p.h. to 10 m.p.h., at a deceleration of not more than 10 f.p.s.p.s. If instrument repair, replacement, or adjustment is necessary, make not more than 10 additional stops or snubs after such repair, replacement of adjustment.

S7.3 *Service brake system—first (preburnish) effectiveness test.* Make six stops from 30 m.p.h. with a pedal force of 15 to 100 pounds. Then make six stops from 60 m.p.h. with a pedal force of 15 to 120 pounds.

S7.4 *Service brake system—burnish procedure.*

S7.4.1 *Vehicles with GVWR of 10,000 pounds or less.*

S7.4.1.1 *Burnish.* Burnish the brakes by making 200 stops from 40 m.p.h. at 12 f.p.s.p.s. The interval from the start of one service brake application to the start of the next shall be either the time necessary to reduce the initial brake temperature to between 230° F. and 270° F., or the

distance of 1 mile, whichever occurs first. Accelerate to 40 m.p.h. after each stop and maintain that speed until making the next stop.

S7.4.1.2 *Brake adjustment—post burnish.* After burnishing, adjust the brakes in accordance with the manufacturer's recommendation.

S7.4.2 *Vehicles with GVWR greater than 10,000 pounds.*

S7.4.2.1 *Burnish.* Burnish the brakes by making 400 snubs from 40 m.p.h. to 20 m.p.h. at 10 f.p.s.p.s. After each brake application accelerate to 40 m.p.h. and maintain that speed until making the next brake application at a point 1.5 miles from the point of the start of the previous brake application.

S7.4.2.2 *Brake adjustment—post burnish.* After burnishing, adjust the brakes in accordance with the manufacturer's recommendation.

S7.5 *Service brake system—second effectiveness test.* Repeat S7.3. Then, with a pedal force of 20 to 150 pounds, make four stops from 80 m.p.h. and four stops from the multiple of 5 m.p.h. that is 4 m.p.h. to 8 m.p.h. less than the speed attainable in 2 miles if that speed is 95 m.p.h. or greater.

S7.6 *Parking brake test.*

S7.6.1 *Vehicle with transmission not utilizing parking mechanisms.* Starting with an initial brake temperature of not more than 150° F., drive the vehicle, loaded to GVWR, onto the grade with the longitudinal axis of the vehicle in the direction of the grade. Apply the service brakes with a force not exceeding 150 pounds to stop the vehicle. Place the transmission in neutral. Apply the parking brakes by exerting a force not exceeding 125 pounds for a foot-operated system, or 90 pounds for a hand-operated system. Release the service brake and allow the vehicle to remain at rest for 5 minutes. Repeat the test

with the vehicle parked in the reverse position on the grade. Check parking brake indicator operation.

S7.6.2 *Vehicles with transmission utilizing parking mechanisms.*

(a) Check that transmission must be placed in park position to release key.

(b) Repeat S7.6.1, except in addition place the transmission control to engage the parking pawl or detent mechanism.

(c) Repeat S7.6.1, except on a 20 percent grade, with the mechanism not engaged.

S7.6.3 *Lightly loaded vehicle.* Repeat S7.6.1 or S7.6.2 as applicable except with the vehicle at lightly loaded vehicle weight.

S7.6.4 *Non service brake type parking brake systems.* For vehicles with parking brake systems not utilizing the service brake friction elements, the friction elements of such systems shall be burnished prior to parking brake tests according to the manufacturer's published recommendations as furnished to the purchaser. If no recommendations are furnished, run the vehicle in an unburnished condition.

S7.7 *Service brake system—lightly loaded vehicle effectiveness test.* Make six stops from 60 m.p.h. with a pedal force of 15 to 120 pounds, with vehicle at lightly loaded vehicle weight.

S7.8 *Service brake system test—partial failure.*

S7.8.1 With vehicle at lightly loaded vehicle weight, alter the service brake system to induce a complete loss of braking, including normal pedal travel loss, in any one subsystem. Determine the pedal force (or pressure level in a brake power unit system) necessary to cause the brake system indicator to operate. Make four stops from 60

m.p.h. by a continuous application of the service brake control with a pedal force not exceeding 150 pounds. Restore the service brake system to normal at completion of this test.

S7.8.2 Repeat S7.8.1 for each of the other subsystems.

S7.8.3 Repeat S7.8.1 and S7.8.2 with vehicle at GVWR. Determine that the brake system indicator is operating when the reservoir fluid level is less than the level specified in S5.3.1(b). Check for proper operation with each reservoir in turn at a low level. Restore the service brake system to normal at completion of this test. The fully applied worn condition is determined with the automatic adjusting mechanism inoperative (for vehicles equipped with self-adjusting mechanism), or without adjustment after setting to the manufacturer's initial new lining condition (for vehicles equipped with manual adjustment mechanism).

S7.8.4 (For vehicles with antilock and brake proportioning systems.) With vehicle at GVWR, disconnect power source, or otherwise render antilock or brake proportioning system inoperative. Make four stops from 60 m.p.h. with a pedal force not exceeding 150 pounds. If more than one independent antilock or brake proportioning system is provided, disconnect or render one subsystem inoperative and run as above. Restore system to normal at completion of this test. Repeat for each subsystem provided. Disconnect electrical power source to unit. Check for operation of warning indicator.

S7.9 *Service brake system—inoperative brake power unit or brake power assist unit test.* (For vehicles equipped with brake power unit or brake power assist unit.) On vehicles with brake power assist units, render the brake power assist unit inoperative, or one of the brake power assist unit systems if entirely independent duplicate systems are provided, by disconnecting the relevant power supply. Exhaust any residual brake power reserve capability of the disconnected system. On vehicles with brake

power units, disconnect the primary source of power. Make four stops from 60 m.p.h. by a continuous application of the service brake control with a pedal force not to exceed 150 pounds. Restore the system to normal at completion of this test. For vehicles equipped with more than one brake power unit or brake power assist unit, conduct tests of each in turn.

S7.10 *Service brake system—first fade and recovery test.*

S7.10.1 *Baseline check stops or snubs.*

S7.10.1.1 *Vehicles with GVWR of 10,000 pounds or less.* Make three stops from 30 m.p.h. at 10 f.p.s.p.s. for each stop, terminating pedal force readings when vehicle speed falls to 5 m.p.h. Average the maximum brake pedal force required for the three stops.

S7.10.1.2 *Vehicles with GVWR greater than 10,000 pounds.* With transmission in neutral (or declutched), make three snubs from 40 to 20 m.p.h. at 10 f.p.s.p.s. for each snub. Average the maximum brake pedal force required for the three snubs.

S7.10.2 *Fade stops or snubs.*

S7.10.2.1 *Vehicles with GVWR of 10,000 pounds or less.* Make 10 stops from 60 m.p.h. at 15 f.p.s.p.s. for each stop. Establish an initial brake temperature before the first brake application of 130° to 150° F. Initial brake temperatures before brake applications for subsequent stops are those occurring at the distance intervals. Attain the required deceleration within 1 second and, as a minimum, maintain it for the remainder of the stopping time. Leave an interval of 0.4 mile between the start of brake applications. Accelerate immediately to the initial test speed after each stop. Drive 1 mile at 30 m.p.h. after the last fade stop, and immediately follow the recovery procedure specified in S7.10.3.1.

S7.10.2.2 *Vehicles with GVWR greater than 10,000 pounds.* With transmission in neutral (or declutched) make 10 snubs from 40 to 20 m.p.h. at 10 f.p.s.p.s. for each snub. Establish an initial brake temperature before the first brake application of 130° F. to 150° F. Initial brake temperatures before brake application for subsequent snubs are those occurring in the time intervals specified below. Attain the required deceleration within 1 second and maintain it for the remainder of the snubbing time. Leave an interval of 30 seconds between snubs (start of brake application to start of brake application). Accelerate immediately to the initial test speed after each snub. Drive for 1.5 miles at 40 m.p.h. after the last snub and immediately follow the recovery procedure specified in S7.10.3.2.

S7.10.3 *Recovery stops or snubs.*

S7.10.3.1 *Vehicles with GVWR of 10,000 pounds or less.* Make five stops from 30 m.p.h. at 10 f.p.s.p.s. for each stop. Allow a braking distance interval of not more than 1 mile. Immediately after each stop accelerate at maximum rate to 30 m.p.h. and maintain that speed until making the next stop. Record the maximum pedal force for each stop.

S7.10.3.2 *Vehicles with GVWR greater than 10,000 pounds.* With transmission in neutral (or declutched) make five snubs from 40 to 20 m.p.h. at 10 f.p.s.p.s., for each snub. After each snub, accelerate at maximum rate to 40 m.p.h. and maintain that speed until making the next brake application at a point not more than 1.5 miles from the point of the previous brake application. Record the maximum pedal force for each snub.

S7.11 *Service brake system—first reburnish.* Repeat S7.4, except make 35 burnish stops or snubs instead of 200 stops or 400 snubs. Do not adjust brakes after reburnish.

S7.12 *Service brake system—second fade and recovery test.* Repeat S7.10, except in S710.2 run 15 fade stops or 20 snubs instead of 10.

S7.13 *Second reburnish.* Repeat S7.11.

S7.14 *Service brake system—fourth effectiveness test.* Repeat S7.5.

S7.15 *Service brake system—water recovery test.*

S7.15.1 *Baseline check stop.* Make three stops from 30 m.p.h. at 10 f.p.s.p.s. for each stop, terminating pedal force readings when vehicle speed falls to 5 m.p.h. Average the maximum brake pedal force required for the three stops.

S7.15.2 *Wet brake recovery stops.* With the brakes fully released at all times, drive the vehicle for not less than 2 minutes at a speed of 5 m.p.h., in any combination of forward and reverse directions, through a trough having a water depth of 6 inches. After leaving the trough, immediately accelerate at maximum rate to 30 m.p.h. without a brake application. Immediately upon reaching that speed make five stops, each from 30 m.p.h. at 10 f.p.s.p.s. for each stop. After each stop (except the last), accelerate the vehicle immediately at a maximum rate to a speed of 30 m.p.h. and begin the next stop.

S7.16 *Spike stops.* Make 10 successive spike stops from 30 m.p.h. with the transmission in neutral, with no reverse stops. Make spike stops by applying a pedal force of 200 pounds while recording pedal force versus time. Maintain pedal force until vehicle has stopped. At completion of 10 spike stops, make six effectiveness stops from 60 m.p.h. with a pedal force of 15 to 120 pounds.

S7.17 *Final inspection.* Inspect—

(a) The service brake system for detachment or fracture of any components, such as brake springs and brake shoes or disc pad facing.

(b) The friction surface of the brake, the master cylinder or brake power unit reservoir cover and seal and filler openings, for leakage of brake fluid or lubricant.

(c) The master cylinder or brake power unit reservoir for compliance with the labeling and volume requirements of S5.4.2 and S5.4.3.

(d) The brake system indicator light, for compliance with operation in various key positions, lens color, labeling and location, in accordance with S5.3.

S7.18 *Moving barrier test.* (Only for vehicles that have been tested according to S7.6.2.) Load the vehicle to GVWR, release parking brake and place the transmission selector control to engage pawl or detent mechanism. With a moving barrier as described in paragraph 3.3 of SAE Recommended Practice J972 "Moving Barrier Collision Tests," November 1966, impact the vehicle from the front at 2½ m.p.h. The longitudinal axis of the barrier is parallel with the longitudinal axis of the vehicle. Repeat the test, impacting the vehicle from the rear.

TABLE I—BRAKE TEST PROCEDURE SEQUENCE AND REQUIREMENTS

Number	Sequence	Test load		Test procedure	Requirements
		Light	GVWR		
1	Instrumentation check			S7.2	
2	First (preburnish) effectiveness test		X	S7.3	S5.1.1.1
3	Burnish procedure		X	S7.4	
4	Second effectiveness		X	S7.5	S5.1.1.2
5	Parking brake	X	X	S7.6	S5.2.1
					S5.2.2
6	Third effectiveness (lightly loaded vehicle)	X		S7.7	S5.1.1.3
7	Partial failure	X	X	S7.8	S5.1.2
8	Inoperative brake power and power assist units		X	S7.9	S5.1.3
9	First fade and recovery		X	S7.10	S5.1.4
10	First reburnish		X	S7.11	
11	Second fade and recovery		X	S7.12	S5.1.4
12	Second reburnish		X	S7.13	
13	Fourth effectiveness		X	S7.14	S5.1.1.2
14	Water recovery		X	S7.15	S5.1.5
15	Spike stops		X	S7.16	S5.1.6
16	Final inspection			S7.17	S5.6
17	Parking brake pawl or detent systems		X	S7.18	S5.2.2.3

TABLE II—STOPPING DISTANCES AND PEDAL FORCES

Vehicle test speed, m.p.h.	Stopping distance in feet for tests indicated									Pedal forces, pounds (inclusive)
	I			II			III			
	1st (reburnish) effectiveness			2nd and 4th effectiveness; lightly loaded vehicle (third) effectiveness; spike effectiveness check			Inoperative brake power and power assist unit; partial failure			
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)	
30	[1] 54	[1] 61	[1] 70	[1] 49	[1] 54	[1] 60	108	121	139	15-100
35	74	83	95	67	74	81	147	165	189	Col. I
40	96	108	123	87	96	105	192	216	246	15-120
45	121	137	156	110	121	134	242	273	312	Col. II
50	150	169	193	135	150	167	299	337	385	15-120
55	181	204	233	163	181	204	362	407	465	Col. III
										15-150
60	[1]216	[1]242	[1]277	[1]194	[1]216	245	[1]431	[1]484	[1]553	
65				240	253	292				20-150
70				278	293	346				
75				319	337	402				
80				[1] 363	[1] 383	[1] 467				
85										
90				484	484					
95				540	540					
100				598	598					
105				659	659					
110				723	723					
115				791	791					
120 [2]				861	861					

[1] Distances for specified tests.

[2] For speeds in excess of 120 m.p.h. use $S = 0.060\ V^2$ where S is stopping distance in feet and V is test speed in miles per hour.

(a) Passenger cars.

(b) Vehicles other than passenger cars with GVWR of 10,000 pounds or less.

(c) Vehicles other than passenger cars with GVWR greater than 10,000 pounds.

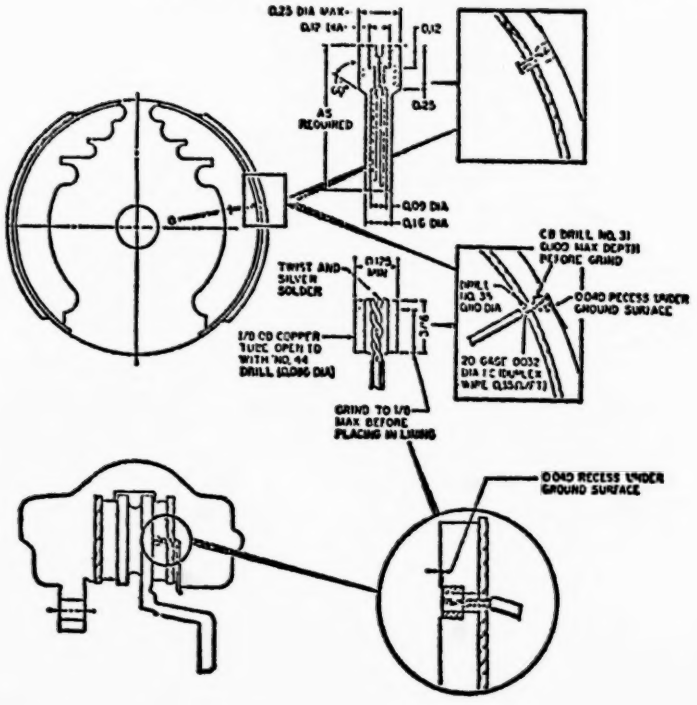

FIGURE 1 - TYPICAL PLUG TYPE THERMOCOUPLE INSTALLATIONS

[37 F.R. 17972, Sept. 2, 1972; 37 F.R. 19138, Sept. 19, 1972]

§ 571.106 Standard No. 106; Hydraulic brake hoses.

S1. *Purpose and scope.* This standard specifies requirements for hydraulic brake hoses that will reduce brake failures due to fluid leakage.

S2. *Application.* This standard applies to hydraulic brake hoses for use in passenger cars and multipurpose passenger vehicles.

S3. *Requirements.* Hydraulic brake hoses shall meet the requirements of Society of Automotive Engineers Standard J40b, "Automotive Brake Hoses," July 1966, except as follows:

(a) Delete "Water Absorption Test."

(b) Add "viscose" and "polyester" to acceptable braid materials.

(c) Specify the following dates for referenced ASTM tests:

(1) ASTM D 571—1955; and

(2) ASTM B 117—1964.

(d) Revise "End Connections" paragraph to read: "Exposed steel or brass end connections of the hose assembly shall be protected against rust or corrosion."

§ 571.107 Standard No. 107; Reflecting surfaces.

S1. *Purpose and scope.* This standard specifies reflecting surface require-